Adult and Juvenile Coho Salmon Enumeration and Coded-wire Tag Recovery Analysis for Zolzap Creek, BC, 2004

B.E. Baxter and C.Y. Stephens

Fisheries and Oceans Canada
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ADULT AND JUVENILE COHO SALMON ENUMERATION AND CODED-WIRE TAG RECOVERY ANALYSIS FOR ZOLZAP CREEK, BC, 2004

prepared by

Bruce E. Baxter and Cheryl Y. Stephens

LGL Limited
environmental research associates[1]

for the

Nisga'a Lisims Government[2]

[1]9768 Second St., Sidney, BC V8L 3Y8
[2]PO Box 228, New Aiyansh, BC V0J 1A0

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ABSTRACT

Baxter, B.E. and C.Y. Stephens. 2005. Adult and juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 2004. Can. Manusc. Rep. Fish. Aquat. Sci. 2730: vii + 58 p.

Adult and juvenile coho migrations were monitored at Zolzap Creek, British Columbia, as part of the 2004-2005 Nisga'a Fisheries Program. The 2004 season is the thirteenth year of continuous operation of the Zolzap Creek fences since 1992. This report includes thirteen year summaries of the most pertinent data. Smolt trapping was conducted from 23 April to 1 June 2004 using an in-stream wire-mesh fence. A total of 27,799 coho smolts were captured during the trapping period, and an unknown number migrated out during periods when the fence was not operational. Of those captured, 25,742 were released with coded-wire tags. Migration timing, mean length and weight at age, and age composition are presented.

Adult coho escapement was monitored using an in-stream floating fence and carcass surveys. The counting fence was operational between 23 August and 10 November. A total of 393 adult coho were counted at the fence with an estimated escapement of 1,631 (95% CL: 1,269 to 2,094) using the adjusted Peterson model. Adipose clip rate was 42.5% for adult coho. Age and length characteristics of adult males and females are presented.

Canadian and US commercial harvests were examined using coded-wire tag recovery data obtained from the Mark-Recovery Program and the Alaska Department of Fish and Game (ADF&G) mark tag and age lab online searchable database. Total exploitation rate on Zolzap Creek coho in 2004 was estimated at 46.0% (4.9% Canadian, 41.1% US). Of the total commercial catch of Zolzap Creek coho, Canadian catch accounted for 10.6% and the US catch accounted for an estimated 89.4%. Harvests occurred over a wide area ranging from SE. Alaska to the US Northern Outside Statistical Area in Alaska (northwest of Juneau, AK). Limited Canadian commercial harvests occurred in Areas 1-5 for Zolzap Creek in 2004. US harvests of Zolzap coho in Alaska were largest in the Southern Inside Statistical Area for the net fishery and the Central Outside Statistical Area for the troll fishery. Total survival was estimated at 4.9% and smolt-to-spawner survival at 2.6%.

RÉSUMÉ

Baxter, B.E. and C. Y. Stephens. 2005. Adult and juvenile coho salmon enumeration and coded-wire tag recovery analysis for Zolzap Creek, BC, 2004. Can. Manusc. Rep. Fish. Aquat. Sci. 2730: vii + 58 p.

Les migrations de saumons coho, adultes et jeunes, ont été mesurées au ruisseau Zolzap en Colombie-Britannique, dans le cadre de la Stratégie des pêcheries autochtones des Nisga'a en 2004-2005. L'année 2004 marque la 13ième saison d'opération continue des barrières en fil métallique du ruisseau Zolzap depuis 1992. Ce rapport contient 13 sommaires annuels des données les plus intéressantes. Le piégeage des saumoneaux prit place entre le 23 avril et le 1 juin 2004 à l'aide d'une barrière en fil métallique installée dans le ruisseau. En tout, 27,799 saumoneaux coho ont été capturés pendant la période de piégeage tandis qu'un nombre inconnu a migré quand la barrière n'était pas opérationelle. Sur l'ensemble des saumoneaux capturés, 25,742 ont été remis à l'eau avec une marque magnétique codée. La période de migration, la longueur moyenne, le poids et la composition selon l'âge sont présentés.

L'échappée de saumons coho adultes a été surveillée grâce à une barrière flottante installée dans le ruisseau et à l'observation des carcasses. La barrière de comptage fut opérationelle entre le 23 août et le 10 Novembre. Un total de 393 saumons coho adultes ont été dénombrés à la barrière avec une échappée estimée à 1,631 (95%CL : 1,269 à 2,094) utilisant le model Peterson ajusté. Le taux d'ablation de la nageoire adipeuse était de 42.5% pour les saumons coho adultes. Nous présentons les caractéristiques d'âge et de longueur pour les adultes mâles et femelles.

Les récoltes commerciales canadiennes et américaines ont été examinées grâce aux données de récupération des marques magnétiques codées provenant du Programme de marquage-récupération et en direct de la base de données du Département de Pêche et Chasse de l'Alaska. En 2004 le taux total d'exploitation de saumons coho au ruisseau Zolzap fut évalué à 46.0% (4.9% pour le Canada, 41.1% pour les États-Unis). Sur le total de prises commerciales de saumons coho au ruisseau Zolzap, le Canada en comptait 10.6% et les États-Unis, une estimation de 89.4%. Les récoltes couvraient un vaste secteur, s'étendant à partir du sud-est de l'Alaska jusqu'à la zone statistique nord extérieure de l'Alaska aux États-Unis (au nord-ouest de Juneau, AK). Des récoltes commerciales Canadiennes limitées ont prit place dans le secteur 1-5 pour le ruisseau Zolzap en 2004. Les saumons coho du Zolzap récoltés par les États-Unis en Alaska furent plus nombreux dans la zone statistique sud intérieure pour la pêche au filet, et, dans la zone statistique centrale extérieure pour la pêche à la traîne. Le taux total de survie fut estimé à 4.9% tandis que pour les saumoneaux/géniteurs le taux de survie fut estimé à 2.6%.

INTRODUCTION

As part of the Aboriginal Fisheries Strategy (AFS), a program was established for fisheries research in the Nisga'a Traditional Territory, British Columbia. One component of this large research initiative focused on the assessment of juvenile and adult coho populations in tributaries to the Nass River. Juvenile and adult coho enumeration studies have been conducted on Zolzap Creek since 1992 (Nass 1996a; Nass 1996b; Nass 1996c; Nass and English 1994; Nass 1997a; Nass 1997b; Nass 2001; Nass and Frith 2001; Baxter et al. 2001; Baxter and Stephens 2002, Baxter and Stephens 2002a, Baxter and Stephens 2002b, Baxter 2003, Baxter and Stephens 2004). This report presents results for studies conducted at Zolzap Creek in 2004.

The objectives of the research were to:

1. Enumerate migrating juvenile coho and estimate escapement;
2. Document the timing, size, and age distribution of migrating coho;
3. Mark coho smolts with coded-wire tags (CWT) to enable the determination of oceanic harvest rates;
4. Monitor the escapement for marked CWT adult coho, and determine ocean exploitation and survival rates; and
5. Collect water temperature and level data for future examination of the relationships between physical environmental factors and coho smolt migration timing, and between adult escapement and smolt production.

Achievement of these objectives involved the construction and operation of in-stream, semi-permanent, panel fences located approximately 0.5 km upstream of the mouth of Zolzap Creek.

STUDY STREAM

Zolzap Creek is a tributary to the Nass River, located in northwestern British Columbia (Figures 1 and 2). Zolzap Creek flows for 6 km in a northwesterly direction between Nisga'a Lava Bed Memorial Park and the Kitimat Mountain Range to its confluence with the Nass River, 5 km downstream of Gitwinksihlkw. The main channel of the creek is regularly interrupted by beaver dams and log jams. The substrate is highly variable and ranges between silty particulate, to granite cobble, and coarse pumice. Major flow contributions come from Lava Creek (3 km in length) which flows from the lava beds and numerous small creeks that flow from the steep alpine. Intermittent flows of water from the Nass River and Vedder Creek are possible during flooding periods. The mouth of Zolzap Creek enters a side channel to the Nass River known as Zolzap Slough. The lower 0.5 km of Zolzap Creek regularly becomes inundated when water levels on the Nass River are high. Zolzap Creek supports many species of salmonids including coho (*Oncorhynchus kisutch*), pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), rainbow

(*O. mykiss*), cutthroat (*O. clarki*), and Dolly Varden (*Salvelinus malma*). Non-coho species include lampreys (family Petromyzontidae), sticklebacks (family Gasterosteidae), and sculpins (family Cottidae). Coho escapement at Zolzap Creek has ranged from 456 in 2000 to 3,233 in 2002, with an overall average of 1,527 for the 1993-2003 period.

JUVENILE COHO STUDIES

METHODS

Trapping Operations

An in-stream, semi-permanent enumeration fence was located 0.5 km upstream of the creek mouth for the capture of downstream migrating coho smolts. Fence design was based on Conlin and Tutty (1979) and minor modifications were required due to site characteristics and available materials. The fence was built in a W-pattern and spanned the entire creek bed. Three-by-eight-foot panels constructed of 2x4's and covered with 1/4" wire-mesh were laid on their long side in the creek bed to form the fence. Rebar of 3/8" and 1/2" diameter were used to anchor the panels to the stream bed. A second layer of panels were installed on top of the first row of panels to create a fence with a total height of six feet. Burlap sandbags and heavy duty plastic garden sheeting were used to seal the base of the panels. Two hinged panels were installed in each of the fence wings for release of excess water in the event of flooding. Plywood trap boxes with Vexar-screened windows (to allow water exchange) were anchored at each down-stream apex and were connected to the fence with 8" Big-O tubing. Additional boxes were made for holding fish after processing and were designed with a small door for releasing fish. Provisions for upstream migrating adults were made by constructing a simple trap consisting of a wire-mesh panel extending out from the stream bank to one wing of the fence. Plywood was used to cover the adult trap area.

Physical Observations

Crews monitored water temperatures, water levels, and weather daily. Crews recorded temperature to the nearest degree (1 °C) using a maximum-minimum thermometer and water level using staff gauges calibrated to the nearest centimeter (0.01 m). A total of three staff gauges were used; two were located within 50 m of the trapping site (one upstream, one downstream of the fence) and one approximately 1 km upstream of the fence. Precipitation was recorded on a scale of zero to five with zero representing no precipitation and five being heavy precipitation.

Fish Enumerations

Daily numbers of coho smolts captured at the fence were obtained from automatic counters on coded-wire tagging machines or by manual counts. The number of fence mortalities was added to the total count. Coho juveniles with standard lengths greater than or equal to 70 mm were identified as smolts. Coho smaller than 70 mm tended to be dark with distinct parr marks and lacked the silver colouration typical of smolts. Therefore, this group consisted of pre-

smolts and fry. All coho pre-smolts and fry, and non-coho species were counted and released downstream of the fence during sorting. Upstream migrating juveniles caught in the adult traps were counted and released upstream.

Biosampling

A random sample of up to 25 smolts (i.e., coho greater than or equal to 70 mm) was obtained from each day's catch. These smolts were anaesthetized and measured for fork length and weighed using an electronic scale (0.1 g). Scale sampling followed the stratified method of Ketchen, described by Ricker (1975); age sample data (column X on Table 1) included non-random samples, and length sample data (column Y on Table 1) and the calculated age representation were based on random sampling. Crews attempted to collect at least 10 scale samples from each 5 mm size class of coho for the study period. Smolts from under-represented size classes were selected to supplement random samples. Mean length and weight data were determined by multiplying the mean length and weight data for each 5 mm bin class by the proportion of the total number of length and weight samples in that bin class (factor) to obtain a weighted mean length and weight for that bin class. The average length and weight for all sampled fish was determined by summing all the weighted length and weight measurements and dividing by the overall sum of the factors. Scale samples were interpreted by the Fisheries and Oceans Canada Scale Lab, Nanaimo, BC. Secondary quality control checks were performed to ensure a reliable age designation. Scale ages are reported in Gilbert-Rich notation where freshwater age-2 coho (i.e., having survived two winters from egg deposition) have a single freshwater annulus.

Coded-wire Tagging

Coded-wire tagging at Zolzap Creek was performed using a Mark IV tagging machine (Northwest Marine Technology Ltd., Shaw Island, WA). Smolts were anaesthetized in a MS222 bath prior to tagging. All tagged fish were adipose fin-clipped (AFC). The numbers of coho smolts tagged with each tag code and the number of untagged smolts were recorded. All tagged smolts were placed in a holding box in the stream and allowed to recover from the tagging operation before release.

Tag retention tests were conducted for each tag code. A sample of tagged coho smolts (minimum of 200 smolts) were retained in a holding box from 24 h to 72 h. Following the holding period, smolts were lightly anaesthetized and checked for the presence of a coded-wire tag using the quality control device (QCD) from the coded-wire tagging machine. Coho smolts not possessing a tag were checked a second time. The total number of tags detected for each tag code and the total number of fish tested were recorded.

RESULTS

Physical Observations

Water temperatures during the smolt migration period at Zolzap Creek ranged from a minimum of 5 °C in late April to a maximum of 10 °C in mid to late May (Table A-1, Figure 3A). Water level at gauge 2 (50 m upstream of the fence) remained steady at a gauge height of approximately 0.4 m from the beginning of monitoring on 25 April until 16 May. Water level rose steadily to a level of 0.5 m from 17 - 19 May then to a level of 0.8m from 20 – 21 May and then rose rapidly to a level of 1.0 m on 22 May (Table A-1, Figure 3A). Water levels subsided rapidly and fluctuated from 0.4 to 0.9 m for the duration of the spring monitoring period. High water levels in Zolzap Creek occur when the Nass mainstem flow rises, causing water to back-up into the creek. Water flow in Zolzap Creek declines to very low velocities during these flooding events.

Fish Enumerations

The Zolzap Creek juvenile counting fence was operated from 23 April to 31 May 2004.

Coho Smolts: A total of 27,799 coho smolts were counted at the fence (Table 2). The maximum daily number of smolts captured at the fence was 2,850 and occurred on 8 May (Table B-1, Figure 4). There were a total of 481 fry and pre-smolt coho counted and released during trapping operations, and three mortalities (Table B-1).

Non-coho Species: Juvenile Dolly Varden were caught in the largest numbers, followed by lampreys (larvae and young adults), adult Dolly Varden, adult cutthroat, and juvenile steelhead (Table 3, Table B-2).

Biosampling: Length, Weight, and Age

The mean fork length of age-2 smolts was 91.1 mm and the mean weight was 7.7 g (Table 1). Age-3 smolts averaged 108.7 mm and 12.9 g, and age-4 smolts averaged 136.9 mm and 25.1 g. The length-frequency distribution showed substantial overlap between age-2 and age-3 coho and between age-3 and age-4 coho (Figure 5). Age-2 smolts were most numerous in the 90 - 95 mm length class, age-3 were most numerous in the 105 – 110 mm length class, and age-4 smolts were most numerous in the 140 - 145 mm length class. Age-3 coho smolts were significantly larger than age-2 smolts (t-test, $p < 0.05$). Overall, coho smolts averaged 95.4 mm in length. The calculated freshwater age structure of coho smolts was 77.4% age-2, 21.4% age-3, and 1.2% age-4 (Table 1).

Coded-wire Tagging

Mean tag retention was 99.2% for tag code 28-01-13, 98.8% for tag code 28-01-14, and 100.0% for tag code 28-01-15 (Table 4). Crews conducted 12 tests for tag code 28-01-13 for a total of 2,399 samples with 18 tag losses, five tests for tag code 28-01-14 for a total of 1,000 samples with 12 tag loss, and three tests for tag code 28-01-15 for a total of 600 samples with zero tag losses.

Releases of adipose fin-clipped coho totalled 25,925 (Table 5; Table C-1). Crews recorded 101 mortalities associated with the tagging process. The total number of coho smolts released with coded-wire tags was 25,742 (Table 5). Approximately 5% (1,255) of the captured coho smolts were released untagged during the study period and thus the mark rate of coho smolts released was 1.06 (Table 5). The total number of smolts released was 27,180.

ADULT COHO STUDIES

METHODS

Fence Design

A uniquely designed weir was constructed at the Zolzap Creek site to address specific site concerns related to extreme variations in water volume and debris load (Figure D-1). The weir design was similar to that used in other studies within the Nass River watershed (Baxter et al. 2005; Miller et al. 2005). It was designed so it could be installed from mid-July to mid-August during a period of low water flows. A modified floating weir design was chosen utilizing a steel sill track combined with an inflatable bladder to keep the downstream end of the weir afloat and well above the water surface.

The base of the weir was constructed of custom steel angle iron, which functioned as a sill rail and was secured to the river bottom in late July under low summer flows. The sill, made up of 3-m lengths, was bolted together in the river, perpendicular to the flow, to a length of 21 m. It was anchored with Duckbill [tm] anchors driven 1 m into the substrate and evenly spaced every 1.5 m. Two Duckbill anchors were used at each of the unions where steel sections bolted together for added strength. The steel sill was placed directly against and on the upstream side of an existing wooden sill dug into the substrate. This placement was to prevent scouring under the sill, as the small gravel substrate was highly mobile and prone to scouring.

In other similar floating weir designs, a heavy steel cable is threaded through eyes attached to the sill rail and the weir panels attach to and pivot on this cable. Problems have been encountered in the past with keeping the cable taught enough to prevent it from sagging. To avoid this potential problem and simplify the design, a 3 m length of steel 5/8" round bar was welded to each length of sill rail on 2.56 cm standoffs to provide attachment and pivot points for the weir panels. With this design, the steel round bar is simply a rigid replacement for the steel cable used in previous floating weir designs.

Weir panel frames consisted of the aluminum weir panels used in previous years at Zolzap Creek combined with aluminum/PVC panels previously used at the Kwinageese River in 2002 (Miller et al. 2005). This was done in order to save the expense of replacing Zolzap weir panels, which were lost in 2003 when the fence was blown out during a high water event. All weir panels were modified to work together in the floating weir design and had eyebolts attached to the bottom of each to secure them to the sill using ¼" shackles.

An inflatable air bladder, 45 cm in diameter typically used for oil spill containment, was used to support all of the weir panels. The air bladder allowed the weir to easily be lowered and raised if required to remove debris or for safety during flood events. It was secured under and near the top end of the weir panels using 3 mm diameter cables and small shackles spaced every 30 cm. The air bladder was constructed with three internal chambers and individually inflated through separate five-centimeter Monsun^{tm} valves using an industrial backpack leaf blower.

An overhead cable was installed approximately 2 m over the downstream edge of the weir and anchored to trees on both banks. This cable was used with vertically hung ropes to hold the ends of the weir panels above water during air bladder installation and as a back-up to support the weir during high flows or in the event the air bladder was damaged or failed.

Trap boxes for capturing fish were located near the left and right banks. The trap box at the right bank was located 1.5 m from the bank abutment and at the end of the floating fence, a single rigid weir panel was used between the trap box and the abutment. The trap box at the left bank was located 5 m from the left bank abutment and utilized a modified weir panel and a custom PVC pipe tunnel to guide fish into the trap.

Population Estimates

All salmonids caught at the fence were counted and classified by sex. Sex was distinguished on the basis of length and body morphology. Previous studies at Zolzap Creek (Nass 1996b, 1996c, 1997a, 1997b, Nass 2001, Nass and Frith 2001, Baxter et al. 2001, Baxter and Stephens 2002, Baxter and Stephens 2002a, Baxter and Stephens 2002b, Baxter 2003, Baxter and Stephens 2004) have shown an absence of jacks in the escapement, and therefore all males were classified as adults. Each coho was tagged on the operculum with a uniquely numbered Ketchum kurl-lock tag and measured for length. During handling, fish were examined for fin clips or tags that would be associated with coded-wire tagging or mark-recapture studies taking place on the Nass River. All captured fish were released upstream of the fence.

Adult coho abundance downstream of the fence was assessed later in the migration period due to the lack of fish movement past the fence. Delayed migration was the result of persistent low water conditions in Zolzap Creek in the later fall period. During these periods of delayed fish movement, angling was conducted approximately 1 km downstream of the fence in Zolzap Slough to determine relative coho abundance. Live coho were recaptured in upstream surveys and checked for operculum tags. Carcasses were recovered on the fence and during upstream surveys. In 2004, carcasses were recovered primarily in the lower 5 km of the creek.

Biosampling

All live coho captured at the fence were measured for postorbital-hypural length and examined for fin clips and sex. Data recorded from coho captured at the fence were used to calculate sex ratios and mean-length by sex. Crews attempted to sample at least 25 coho a day for scales (5 scales per fish). Scale samples were sent to the Fisheries and Oceans Canada Scale Lab, Nanaimo, BC. Secondary quality control checks were performed at the scale lab to ensure reliability of the age designations. Scale ages are reported in Gilbert-Rich notation where freshwater age-2 coho (i.e., having survived two winters from egg deposition) have a single freshwater annulus.

Adult returns (calculated by escapement method) and smolt production, by CWT and total populations, were calculated for each brood year where data was available. Smolt output and adult escapement were apportioned between brood years (back-calculated) using the age structure observed in the respective yearly migrations. The sum of freshwater age-2, age-3, and age-4 individuals equals total production for a given brood year. Age composition for smolts and adults by brood year were calculated based on the estimated production. Total survival by brood year was calculated as the age specific adult return divided by the respective smolt production. Smolt-to-spawner recruitment for each brood year was calculated as the number of smolts produced divided by the number of adults in the escapement, by brood year. Similarly, the recruit-to-spawner ratio for each brood year was calculated as the number of adults produced divided by the number of adults in the escapement, by brood year.

Coded-wire Tag Recoveries

Coded-wire-tagged smolts were adipose fin-clipped prior to release. Coho smolts at Zolzap Creek were coded-wire-tagged in the spring of 2003 (Baxter and Stephens 2004) during out-migration.

Escapement: Crews examined all coho captured at the fence for the presence or absence of the adipose fin. The contribution and survival of AFC coho to the escapement was determined using methods presented in Bocking et al. (1992) and modified in Nass (1997a). Coded-wire-tagged heads were collected from fish captured at the Nass River fishwheels, fish recovered in the native angling fishery below and above the fence, and from carcass recoveries.

Commercial and Sport Harvests: Commercial and sport catches of CWT fish are monitored by Fisheries and Oceans Canada and various US agencies and compiled in the Mark Recovery Program (MRP) and in the ADF&G mark tag and age lab online searchable database. Data on CWT releases and recaptures are used to estimate the number of fish from a particular stock that have been harvested in the commercial and sport fishery, as well as determining the spatial and temporal distribution of harvests (Kuhn et al. 1988, Nass 1997a). The estimates include catch (observed catch corrected for sampling effort), expanded catch (estimated catch corrected for unmarked fish), exploitation rate (proportion of CWT coho caught in the fishery), and total return (expanded catch plus escapement).

Geographic Distribution of Harvest: Coded-wire-tagged fish in the commercial catch are recorded by Canadian and US fishery Statistical Areas. To estimate number of recoveries for each Canadian area, the observed CWT catch was expanded by the mean catch-sampling ratio observed in the Catch Region (e.g., Northern Troll = Stat. Areas 1, 3, 4, and 6). Similarly, US troll catch was expanded using the catch sampling ratio by quadrant (e.g., northwest) and the net catch sampling ratios, by district.

RESULTS

Physical Observations

During the period that the adult fence was operational, water temperatures ranged from a maximum of 10 °C in early September to a minimum of 3 °C in late-October (Table A-1, Figure 3B). Water level ranged from 0.3 m during base flows to 1.6 m during freshets (Table A-1, Figure 3B).

Adult enumerations

The fence was operated continuously from 23 August to 10 November. Several high water events occurred over the course of the season but the fence remained intact. A total of 393 adult coho salmon were counted at the fence including one coho released untagged (Table 6). Of these, 392 adults (adjusted for tag loss) were operculum tagged and released upstream. Maximum daily migration past the fence was 104 adults on 11 October (Table D-1, Figure 6).

For non-coho species captured at the fence, chum salmon had the greatest abundance (4), followed by pink salmon (3) and sockeye salmon (3). Cutthroat (2) were also captured at the fence (Table 3). Chum, pink, and sockeye were caught in their greatest numbers in early-mid September. Cutthroat were mainly caught in mid-late September. The number of all non-salmon species caught in 2004 was lower than in 2003 and below the 1992-2003 averages. No population estimates were derived for non-coho species.

Mark-recapture Estimates

Crews examined a total of 248 adult coho (live and dead) collected on the fence, and in twelve upstream surveys (Table E-1). Surveys were conducted upstream of the fence from 16 October to 26 November at three access locations along the creek. Upstream surveys were conducted on 16, 31 October, and 9, 17, 22 November at Goat Creek (a tributary); 19 October, and 1, 2, 12, 19, 26 November at upper Zolzap Creek. Of the 248 adult coho examined, 59 were tagged, and 189 were untagged, which resulted in a Peterson population estimate of 1,631 adults (1,269 to 2,094; 95% CL) escaping to Zolzap Creek in 2004 (Table 6). An undetermined number of coho were observed spawning below the fence and in the Zolzap Slough area, so our estimate of 1,631 adult coho is likely underestimated.

Biosampling - Age and Length

A total of 313 coho were sampled for scales, of which 271 were successfully aged (Table 7). Non-aged samples included marine regenerates. Adult males and females had similar age compositions which averaged 80.0% and 80.5% freshwater age-2, and 20.0% and 19.5% freshwater age-3, respectively. The overall age composition was 79.0% age-2, and 21.0% age-3. All aged scales were recorded as marine age-1 (i.e., having one marine annulus).

Mean lengths of adult males and females were 53.8 cm (n=221, SD=7.8) and 56.6 cm (n=171, SD=6.2), respectively. Adult male coho length was widely distributed over the range of 35 to 72 cm with a mode of 52 cm (Figure 7). Female coho length had a mode of 54 cm with a range of 42 to 72 cm. For coho captured at the fence and sexed during processing, adult males (n=221) were more abundant than females (n=171).

Coded-wire Tag Recoveries

Escapement: Crews examined 391 adult coho at the fence for adipose fin clips and 166 were AFC (42.5%; Table 8). An estimated 692 adipose clipped adult coho returned to Zolzap Creek in 2004. An undetermined number of AFC coho spawned below the fence and in the Zolzap slough area. Smolt to spawner survival (i.e., includes natural and harvest mortality) for adult coho was estimated at 2.6%.

Twelve (12) CWT heads were collected at Zolzap Creek. Of these recoveries, 11 were from the native angling fishery below the fence and one was from carcass recoveries. In addition, seven coho with adipose clips were recovered at the Nass River fishwheels. All of the CWT recoveries from Zolzap Creek were from the 2003 release at Zolzap Creek (codes 28-01-08 28-01-09 and 28-01-12).

Commercial and Sport Harvests: Total observed Zolzap Creek coho CWT recoveries were 21 and 136 for Canadian and US (Alaska) fisheries, respectively (Table 9). Observed sport recoveries totalled zero for the Canadian fisheries and eight for the Alaskan fishery. All CWT recoveries were from the 2003 release year. US troll and net cumulative catch to sample ratios were 3.6 and 6.5, respectively (Table 9). Estimated Zolzap Creek CWT coho catches were 55 (9%) and 533 (91%) for Canadian and US fisheries, respectively, and the total observed in-river angling fishery at Zolzap Creek harvested eight CWT coho (four in the Nisga'a food fishery and four in the non-Nisga'a sport fishery (Table 9).

Expanded Canadian and US catches were 62 and 601, respectively, for a total of 663 using the CWT mark ratio at release (i.e., MRP method) (Table 10). Expanded Canadian and US catches were 130 and 1,255, respectively, for a total of 1,385 using the adipose clip ratio at recovery (i.e., escapement method). Estimated total adult return for Zolzap Creek coho was 1,424 and 3,016 using the MRP and escapement methods, respectively (Table 10).

Of the total commercial catch of Zolzap Creek coho, Canadian fisheries accounted for 9.9% and the US accounted for 90.1% of the total commercial catch of Zolzap Creek coho

(Table 11). US troll and net fisheries accounted for 83.0% and 17.0% of the total US commercial catch, respectively. Canadian troll and net fisheries accounted for 89.1% and 10.9% of the total Canadian commercial catch. Commercial harvest of Zolzap Creek coho occurred over a wide area ranging from Canadian Statistical Area 5 to the US Northern Outside Statistical Area in Alaska (Figure 8). US harvests were largest in the Southern Inside Statistical Area for the net fishery (7.0%) and the Central Outside Statistical Area for the troll fishery (36.4%; Table 11).

Total exploitation rate (Canadian and US combined) on Zolzap Creek coho in 2004 was 46.0% (Table 12). Total Canadian exploitation rate was 4.9% (3.8% troll, 0.5% net, and 0.6% terminal harvest by Nisga'a) and total US exploitation rate was 41.0% (32.0% troll, 6.5% net, and 2.5% sport). Total survival based on CWT returns was 4.9% (Table 12).

DISCUSSION

Over the past 13 years of monitoring, the average number of smolts enumerated leaving Zolzap Creek was 28,408 (Table 12). For the 1990-2000 time period for which complete brood year information is available, the average age composition of the smolt population was 68.0% age-2, 31.2% age-3, and 0.8% age-4 (Table 13).

Adult coho enumerated at the fence in 2004 (393) accounted for 24.1% of the Peterson population estimate (1,631). Therefore, approximately 1,238 adults breached the fence during high water periods or during normal fence operations. An undetermined number of coho were observed spawning below the fence and in Zolzap Slough. The observed native and sport fishery harvested eight CWT coho below the fence. Average escapement estimates for 1992 - 2003 was 1,536 (Table 12).

Data from 1992 to 2003 have indicated that there are no jacks in the Zolzap Creek escapement (Nass 1996b, 1996c, 1997a, 1997b, 2001, Nass and Frith 2001, Baxter et al. 2001, Baxter and Stephens 2002, Baxter and Stephens 2002a, Baxter and Stephens 2002b, Baxter 2003, Baxter and Stephens 2004). In 2004, CWT and scale ageing data have confirmed again the absence of jacks in the population. There were 12 heads taken at Zolzap Creek for CWT sampling from coho measured between 33 and 72 cm (post-orbital-hypural) and all were found to be from 2003 releases. A post-orbital-hypural length of 35 cm has been used in previous studies at other BC streams to designate jacks in the escapement and is based on CWT analysis. Both the CWT analysis and scale ageing show that coho less than 35 cm from Zolzap Creek in 2004 were marine age-1.

The Department of Fisheries and Oceans Canada operates a juvenile and adult fence site at Lachmach River, BC which is used as a Northern BC wild coho indicator stock. Exploitation rates for Lachmach coho have ranged from 21.8% to 70% for the 1994-2001 period (Holtby et al 1999, Barry Finnegan, PBS, Nanaimo, pers. comm.). These exploitation rates are very similar to Zolzap exploitation rates for the 1994-1999 time period (Figure 9). Total survival for Lachmach coho has ranged from 5.5% (1997) to 17.4% (1994) and has been consistently higher than Zolzap

Creek survivals (Figure 10). The Department of Fisheries and Oceans stopped operating Lachmach in 2003.

In Alaska, comprehensive information exists for several southeast stocks, including Hugh Smith Lake (Southern Inside Statistical Area, see Figure 8), which has been monitored since 1982. Preliminary data for the 2004 return suggests exploitation rates of 2.7% Canadian and 62.3% US (65.0% total; Leon Shaul, Alaska Dept. of Fish and Game, Douglas, AK, pers. comm.). Southeast Alaska and Canadian fisheries accounted for approximately 95.8% and 4.2% of the commercial catch of Hugh Smith coho, respectively. The total exploitation rate on Hugh Smith coho (65.0%) was much higher compared to exploitation rates on Zolzap Creek coho (46.0%) in 2004. Preliminary CWT data for the 2004 return of Hugh Smith coho suggest a survival rate of 10.4% which is higher than for Zolzap Creek coho at 4.9%. Hugh Smith coho have had substantially higher survivals (range 6.8% to 19.5%) compared to Zolzap coho (range 2.4% to 11.8%) in the past eleven years.

Zolzap Creek CWT coho have been subjected to total exploitation rates between 19.9% and 72.3% and have had smolt-adult survival rates between 2.1% and 11.8% over the period 1992 to 2004 (Table 12, Figures 9 and 10). Survivals in 2004 were lower than in 2003 and slightly below the 1992-2004 average (Table 12). Canadian fisheries have had exploitation rates between 0% and 21.4% on Zolzap CWT coho, while US fisheries ranged between 16.6% and 54.8% (Figure 11). Of the total catch of Zolzap Creek coho, Canadian fisheries have averaged 16.9% and the US has averaged 83.1%, over twelve years (Table 12).

Total smolt production by brood year averaged 26,602 (1990 - 2000) and was composed primarily of freshwater age-2 fish (68.0%; Table 13). Adult production by brood year averaged 3,322 (1990 - 1999) and was 60.4% age-2 fish. Age composition at return was substantially different from that observed in the respective smolt populations and varied widely. Freshwater age-4 fish were absent from all adult escapements with the exception of the 1995 brood year. Total smolt-adult return by brood year of all Zolzap coho (unmarked + CWT) averaged 12.0% (1990-1999; Table 13). Total smolt-adult return of Zolzap CWT coho was substantially lower at 5.5%. Higher survival for all coho compared to CWT coho is likely due to a significant number of unmarked smolts leaving Zolzap during non-operational periods (Nass 1996c). The effects of these conditions are evident from the historical data which shows the AFC at release has been roughly two to three times that of the AFC rate at return for the period 1993-2004 at Zolzap Creek (Table 8). Therefore, by using only CWT fish, the uncertainty around the number of fish released is eliminated and produces a more accurate estimate of survival for Zolzap coho smolts.

Estimates of total survival and exploitation are based on the assumption that all CWT coho are recovered in fisheries or on the spawning grounds. At Zolzap Creek, it is possible that the escapement of AFC coho is underestimated due to straying. Coho are known to spawn downstream of Zolzap Creek in Zolzap Slough (a side channel to the Nass River) where some CWT coho may return. In addition, a total of seven adipose-clipped coho were recovered in the fishwheels above Zolzap Creek in 2004 (all were from the 2003 release at Zolzap Creek), which tends to confirm our theory of straying. Straying would affect Zolzap Creek survival and exploitation estimates by underestimating survival and overestimating exploitation rates.

Zolzap Creek coho survivals may also be lower than Lachmach and Hugh Smith coho due to predator/prey interactions, with Zolzap Creek coho being more vulnerable to predation during their outmigration. Hugh Smith and Lachmach are both coastal systems and empty directly into marine waters. In contrast, Zolzap Creek empties into the Nass River and coho smolts must migrate approximately 33 km through Riverine habitat until they reach the ocean. This may predispose the smolts to a higher level of predation along the way.

Persistent low water conditions at Zolzap Creek in the fall result in coho holding below the fence in Zolzap Slough until water levels rise. During certain low water years, this may result in coho spawning in the Slough area or pulsing through after the fence is demobilized. During these times, the run timing of the returning adult coho may be more an artifact of water levels rather than natural run timing. High water conditions and flash flooding conditions have occurred during the last three years (2002-2004) and intermittently since the start of the program. Peak flood conditions in 2002 and 2003 resulted in the complete failure of the fence structure and large capital infrastructure costs. In 2004, the culverts located approximately 100 meters upstream of the fence were replaced with a new highway bridge which spanned the width of Zolzap Creek. This will result in flow changes within Zolzap Creek which may have an effect on future in-stream fence designs and trapping operations. It is recommended that a permanent water gauging station be installed by the highway bridge in the spring of 2005 to monitor long term flow changes within Zolzap Creek.

In 2004, a new adult fence design was implemented at Zolzap Creek which consisted of an in-stream floating fence design similar to ones used in previous studies within the Nass River watershed (Baxter et al. 2005; Miller et al. 2005). This new design appeared to be well suited to flows within Zolzap Creek and the fence remained intact under several high flow events over the course of the season. Upstream surveys looking at mark rates indicated that a high number of adult coho passed the fence undetected during normal operations and possibly during high water events. It is recommended that during subsequent years, consideration be given to modifying the fence design in order to make the fence more fish-tight and allow a greater proportion of adult coho to be marked and released upstream of the fence. Continued and increased effort should be apportioned to upstream surveys to ensure accurate mark-recapture estimates and a complete census of returning coho.

The number of smolts per spawner was 34.2 for the 2000 brood year. This value is conservative as the number of smolts released was likely underestimated. The number of recruits per spawner was 9.2 for the 2000 brood year (Table 13).

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TABLES

Table 1. Age-length distribution of Zolzap Creek coho smolts, 2004.

Size-Class (mm)	Age Sample Size (X)	Age-groups in X			Length Sample Size (Y)	Calculated Age Representation in Y		
		2	3	4		2	3	4
70	6	6	0	0	19	19.0	0.0	0.0
75	13	13	0	0	54	54.0	0.0	0.0
80	31	31	0	0	119	119.0	0.0	0.0
85	31	29	2	0	148	138.5	9.5	0.0
90	55	52	3	0	189	178.7	10.3	0.0
95	35	29	6	0	132	109.4	22.6	0.0
100	29	19	10	0	116	76.0	40.0	0.0
105	22	7	15	0	63	20.0	43.0	0.0
110	24	11	13	0	57	26.1	30.9	0.0
115	9	4	5	0	27	12.0	15.0	0.0
120	5	1	4	0	11	2.2	8.8	0.0
125	4	0	3	1	10	0.0	7.5	2.5
130	0	0	0	0	10	0.0	7.5	2.5
135	2	0	2	0	8	0.0	8.0	0.0
140	3	0	1	2	8	0.0	2.7	5.3
145	2	0	1	1	3	0.0	1.5	1.5
150	1	0	1	0	1	0.0	1.0	0.0
Mean length (mm)					95.4	91.1	108.7	136.9
SD					13.4	9.6	7.7	7.8
Mean weight (g)					9.0	7.7	12.9	25.1
SD					4.2	2.4	4.5	4.6
Total samples	272	202	66	4	975	755	208	12
% contribution		74.3	24.3	1.5		77.4	21.4	1.2

Table 2. Coho smolt catch at Zolzap Creek enumeration fence, by week, in 2004.

Week ending	Catch
24-Apr	287
1-May	1,695
8-May	6,272
15-May	4,322
22-May	6,762
29-May	7,199
5-Jun	1,262
Total	27,799

Table 3. Non-coho catch at the spring juvenile and fall adult fences at Zolzap Creek, 1992-2004[a].

Species	Time/lifestage	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	92-03 Avg.
Pink	Fall Adult	115	149	251	52	72	44	23	71	33	60	17	15	3	75
Chum	Spring Juvenile						344	549	79	5	7	12	0	2	142
	Fall Adult	30	111	68	8	19	42	24	32	24	80	5	26	4	39
Sockeye	Spring Juvenile	4	244	328	189	119	0	798	231	98	8	4	173	4	183
	Fall Adult	4	11	28	7	0	39	10	11	5	15	1	9	3	12
Cutthroat	Spring Juvenile	12	69	36	67	121	42	268	141	259	138	118	99	19	114
	Spring Adult	308	278	224	43	55	2	117	30	13	45	135	20	33	106
	Fall Adult	17	27	14	28	18	12	14	28	18	12	12	17	2	18
Dolly Varden	Spring Juvenile	682	309	339	518	711	337	732	647	1095	740	483	735	608	611
	Spring Adult	644	728	1,529	28	44	7	25	5	11	10	89	5	43	260
	Fall Adult	9	21	10	81	39	21	30	174	27	136	3	27	0	48
Steelhead	Spring Juvenile	11	15	36	12	30	4	82	33	41	39	23	4	28	28
	Spring Adult	33	0	5	0	0	0	0	0	0	1	0	0	2	3
	Fall Adult	5	0	2	0	0	0	4	1	4	4	4	1	0	2
Lamprey[b]	Spring Juvenile	749	906	1,277	2,314	1,333	1,794	2,264	1,806	539	1,027	711	357	190	1,256
	Spring Adult	-	-	-	-	28	97	144	199	177	295	193	119	98	157
	Fall Adult	-	-	-	2	16	4	1	0	0	0	0	0	0	3

[a] Trapping effort not equal between years.

[b] Adults and juveniles not distingushed for period 1992 - 1995.

Table 4. Coded-wire tag retention rates for Zolzap Creek coho smolts, 2004.

Sampling Date	Tagging Date	Tag code	Hours held	Sample size	No. fish no tag	Percent retention
27-Apr	26-Apr	28-01-13	24	200	2	99.0
28-Apr	27-Apr	28-01-13	24	200	7	96.5
30-Apr	28-Apr	28-01-13	48	199	0	100
3-May	30-Apr	28-01-13	72	200	0	100
5-May	3-May	28-01-13	48	200	0	100.0
7-May	5-May	28-01-13	48	200	2	99
8-May	7-May	28-01-13	24	200	0	100
9-May	8-May	28-01-13	24	200	2	99
10-May	9-May	28-01-13	24	200	1	99.5
12-May	10-May	28-01-13	48	200	0	100
13-May	12-May	28-01-13	24	200	3	98.5
14-May	13-May	28-01-13	24	200	1	99.5
Subtotal				2,399	18	99.2
17-May	16-May	28-01-14	24	200	4	98
18-May	17-May	28-01-14	24	200	3	98.5
19-May	18-May	28-01-14	24	200	2	99
24-May	23-May	28-01-14	24	200	0	100
25-May	24-May	28-01-14	24	200	3	98.5
Subtotal				1,000	12	98.8
28-May	27-May	28-01-15	24	200	0	100
29-May	28-May	28-01-15	24	200	0	100
31-May	29-May	28-01-15	48	200	0	100
Subtotal				600	0	100.0
Grand Total				3,999	30	99.2

Table 5. Coded-wire tagged coho smolt releases from Zolzap Creek, 2004.

Tag code	Tagging dates	No. AFC	Tag morts	No. released AFC	No. tagged [a]	No. AFC only [b]	No. released untagged [c]	Total release [d]	CWT mark rate [e]
280113	26 April - 12 May	9,669	48	9,621	9,549	72	403	10,024	1.05
280114	13 May - 25 May	11,146	35	11,110	10,999	111	304	11,414	1.04
280115	26 May - 31 May	5,212	18	5,194	5,194	0	548	5,742	1.11
	Total	26,027	101	25,925	25,742	183	1,255	27,180	1.06

[a] No. tagged (corrected for tag loss) = No. released AFC - (No. released AFC * No. lost tags / No. sampled); see Table 4.

[b] No. AFC only = No. released AFC - No. tagged

[c] No. released untagged = the number of unmarked fish released which belong to the same group as the tagged and AFC only fish.

[d] Total release = No. tagged + AFC only + untagged

[e] CWT mark rate = Total release / No. tagged

Table 6. Fence enumerations, carcass recoveries, and Petersen population estimates for adult coho escapement at Zolzap Creek, 2004.

Item	Adults	Total
Number live coho captured at fence	393	393
Number of live coho released untagged	1	1
Number live coho operculum tagged	392	392
Number coho carcasses recovered	248	248
Number of coho carcasses recovered untagged	189	189
Number of coho carcasses recovered tagged	59	59
Petersen estimate	1,631	1,631
Upper 95% CL	2,094	2,094
Lower 95% CL	1,269	1,269

Table 7. Freshwater age distribution of adult coho at Zolzap Creek, 2004.

Sex	Age-2		Age-3		Total aged	Total unaged	Total sampled
	No.	%	No.	%			
Adult males	96	80.0	24	20.0	120	19	139
Adult females	70	80.5	17	19.5	87	9	96
Unsexed	48	75.0	16	25.0	64	14	78
Total adults	214	79.0	57	21.0	271	42	313

Table 8. Estimates of total escapement of adipose clipped coho and contribution to escapement at Zolzap Creek, 1993-2004.

Escapement Year	No. examined (A)	No. with adipose clips (B)	% AFC (C=B/Ax100)	Population estimate (D)	% sampled (E=A/Dx100)	Estimated adipose clips (F=B/AxD)	No. smolts [a] AFC	No. smolts [a] unclipped	No. smolts [a] % AFC	Contribution to escap. [b]	Smolt to spawner (%) [c]
1993	784	191	24.4	1,048	74.8	255	33,923	6,678	83.6	306	0.8
1994	2,416	499	20.7	2,536	95.3	524	22,986	3,348	87.3	600	2.3
1995	906	308	34.0	908	99.8	309	29,615	4,804	86.0	359	1.0
1996	1,030	218	21.2	1,039	99.1	220	10,166	2,203	82.2	268	2.2
1997	462	201	43.5	470	98.3	204	20,625	1,265	94.2	206	0.9
1998	963	212	22.0	967	99.6	213	13,566	992	93.2	228	1.6
1999	1,294	451	34.9	1,393	92.9	486	13,950	1,771	88.7	547	3.5
2000	409	260	63.6	456	89.7	290	14,591	233	98.4	295	2.0
2001	1,893	1,155	61.0	1,897	99.8	1,157	30,304	3,212	90.4	1,280	3.8
2002	1,905	883	46.4	3,233	58.9	1,499	22,385	4,427	83.5	1,795	6.7
2003	1,416	432	30.5	2,855	49.6	871	12,412	468	96.4	904	7.0
2004	391	166	42.5	1,631	24.0	692	27,131	2,662	91.1	760	2.6
Avg.	1,225	437	36.6	1,527	87	548	20,411	2,673	89	617	2.9

[a] smolt releases of the previous migration year; an unknown number of additional unclipped releases were likely.

[b] marked contribution to escapement = estimated adipose clips * (clipped + unclipped) / clipped.

[c] % survival = estimated AFC + AFC below the fence / AFC smolts* 100.

Table 9. Estimated Canadian and American commercial and sport harvest of Zolzap Creek CWT coho in 2004 using tag recovery data (Mark Recovery Program, Fisheries and Oceans, Canada and ADF&G mark tag and age lab, online searchable database).

Tag	Observed CWT catch [a]				Catch-sample ratio [b]			Estimated CWT catch [c]			
code	N. Troll	N. Net	Sport	Total	N. Troll	N. Net	Sport	N. Troll	N. Net	Sport	Total
Canadian											
28-01-08	6	0	0	6	2.4	0.0	0.0	15	0	0	15
28-01-09	6	1	0	7	2.4	6.4	0.0	15	6	0	21
28-01-12	8	0	0	8	2.4	0.0	0.0	20	0	0	20
Total	20	1	0	21	2.4	6.4	0.0	49	6	0	55
American											
28-01-08	62	4	4	70	3.8	10.9	4.0	235	44	16	294
28-01-09	37	5	2	44	3.4	4.6	4.7	126	23	9	159
28-01-12	16	4	2	22	3.4	4.5	3.7	55	18	7	80
Total	115	13	8	136	3.6	6.5	4.1	415	85	33	533
Total	135	14	8	157	3.4	6.5	4.1	464	91	33	588

Total commercial	555
Total sport	33
Total in-river angling fishery [d]	8
Total escapement [e]	699
Total CWT	1,296

[a] Observed CWT = CWT's recovered from the commercial and sport catch

[b] Cumulative catch-sample ratio = total coho catch / total coho sampled

[c] Estimated CWT = observed CWT catch * catch sampling ratio

[d] includes observed harvest (Nisga'a and non-Nisga'a).

[e] Estimated CWT's (adipose clips corrected for tag loss at return) including those below the fence, and at the fishwheels; see Table 8

Table 10. Expanded Canadian and American commercial and sport harvest of Zolzap Creek coho and estimated total return in 2004 from 2003 smolt year.

Tag code	Total release	Smolts tagged [a]	Mark rate [b]	Expanded catch [c]									Contri-bution escap.	Total return [d]
				Canadian				American				Grand Total		
				Troll	Net	Sport	Total	Troll	Net	Sport	Total			
28-01-08	9,915	9,067	1.09	16	0	0	16	257	48	18	322	338		
28-01-09	12,239	9,911	1.23	18	8	0	26	156	28	12	196	222		
28-01-12	7,639	7,327	1.04	20	0	0	20	57	19	8	83	104		
Total 1 [e]	29,793	26,305	1.13	54	8	0	62	469	95	37	601	663	760	1,424
Total 2 [f]			2.36	115	15	0	130	978	199	78	1,255	1,385	1,631	3,016

[a] Number smolts released with tags (corrected for tag loss), Nass and Frith 1997.

[b] Mark rate at release (= No. released / No. marked) for smolts and Total 1 (MRP method), and mark rate at return for total 2 (Escapement method).

[c] Expanded catch = EST * mark rate at release.

[d] Total return = expanded catch + escapement.

[e] Total 1 expanded catch is calculated using the total mark rate at release and the total estimated catch for all tag codes (Table 9).

[f] Total 2 expanded catch is calculated using the total adipose clip rate at recovery and the total estimated catch for all tag codes (Table 9).

Table 11. Estimated commercial harvest distribution of Zolzap Creek CWT coho by area and gear type, 2004. (Percentage is of total commercial harvest, does not include sport recoveries).

Area [a]	Net	%	Troll	%	Total	%
Canada						
Areas 1-5	6	1.2	49	8.8	55	9.9
subtotal	6	1.2	49	8.8	55	9.9
U.S.A. (Alaska)						
Northern Outside	0	0.0	9	1.7	9	1.7
Central Outside	0	0.0	202	36.4	202	36.4
Southern Outside	13	2.3	51	9.2	64	11.6
Southern Inside	39	7.0	43	7.7	82	14.7
Central Inside	33	5.9	3	0.6	36	6.5
Southern Intermediate	0	0.0	78	14.1	78	14.1
[c] Expanded catch = EST [c]	0	0.0	5	0.8	5	0.8
[d] Total return = expanded	0	0.0	23	4.2	23	4.2
subtotal	85	15.2	415	74.8	500	90.1
TOTAL	91	16.4	464	83.6	555	100.0

[a] includes respective sub-areas

Table 12. Adult and juvenile coho abundance and smolt-adult survival, by smolt year, at Zolzap Creek, 1992-2004.

Smolt Out-migration				Resulting Escapement			Total Return							Catch			Smolt-total return Surv. (%)	
Smolt Year	Count	Estimate A	CWT B	Return Year	Count	Estimate	Return Year	Expanded C	Estimated CWT D	% Esc	% Can	%US	%Can + US	Return Year	% Can	%US	Expanded C/A	Estimated CWT D/B
1992	40,601	53,000	33,150	1993	794	1,048	1993	2,832	690	37.0	15.5	47.5	63.0	1993	24.6	75.4	5.3	2.1
1993	26,334	51,000	22,649	1994	2,438	2,536	1994	9,645	2,025	27.7	18.6	53.7	72.3	1994	25.7	74.3	18.9	8.9
1994	34,419	41,000	29,319	1995	908	908	1995	3,057	1,069	32.3	12.9	54.8	67.7	1995	19.0	81.0	7.5	3.6
1995	12,369	13,000	10,156	1996	1,039	1,039	1996	3,159	674	39.5	21.4	39.2	60.5	1996	35.3	64.7	24.3	6.6
1996	20,745	23,000	20,519	1997	470	470	1997	1,072	486	45.8	8.8	45.4	54.2	1997	16.2	83.8	4.7	2.4
1997	15,099	18,000	13,566	1998	967	967	1998	1,986	400	54.0	0.0	46.0	46.0	1998	0.0	100.0	11.0	2.9
1998	15,937	19,000	13,900	1999	1,302	1,393	1999	2,808	980	50.5	1.2	48.3	49.5	1999	3.1	96.9	14.8	7.1
1999	15,153	16,000	14,572	2000	409	456	2000	955	623	48.0	11.1	40.9	52.0	2000	21.4	78.6	6.0	4.3
2000	33,934	34,500	30,132	2001	1,897	1,897	2001	3,765	2,315	50.2	7.8	42.0	49.8	2001	15.7	84.3	10.9	7.7
2001	27,948	28,000	22,216	2002	1,918	3,233	2002	4,030	1,874	80.1	3.3	16.6	19.9	2002	16.5	83.5	14.4	8.4
2002	15,001	15,000	12,318	2003	1,444	2,855	2003	4,641	1,457	59.9	6.1	34.0	40.1	2003	15.1	84.9	30.9	11.8
2003	30,005	30,005	26,305	2004	393	1,631	2004	3,016	1,296	54.0	4.9	41.1	46.0	2004	10.6	89.4	10.1	4.9
2004	27,799	27,799	25,742	2005	-	-	2005	-	-	-	-	-	-	2005	-	-	-	-
Average	24,257	28,408	21,119		1,165	1,536		3,414	1,157	48.2	9.3	42.5	51.8		16.9	83.1	13.2	5.9

Estimate A = Best estimate of total smolt outmigration based on fence counts and migration patterns.

CWT B = Number of smolts that were Coded-wire tagged during their outmigration.

Estimate C = Expanded catch using total adipose clip rate at recovery and the total estimated catch for all tag codes.

CWT D = Estimated catch and escapement of Zolzap Creek CWT coho by tag code, including commercial, sport, native, fishwheel recoveries.

Table 13. Adult and juvenile coho production by freshwater age class and brood year, Zolzap Creek, 1990-2000[a].

All fish

Brood	Smolt Production (by freshwater age)				Adult Return (by freshwater age)				Smolts (freshwater age)			Escapement (freshwater age)[c]			Smolt to Adult Return Survival (% by freshwater age)			
Year	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Age 4	Total	% Age 2	%Age 3	%Age 4	% Age 2	%Age 3	%Age 4	Age 2	Age 3	Age 4	Overall
1990	28,779	16,371	287	45,437	1,651	3,819	0	5,470	63.3	36.0	0.6	30.2	69.8		5.7	23.3	0.0	12.0
1991	34,629	28,495	910	64,034	5,826	1,794	0	7,620	54.1	44.5	1.4	76.5	23.5		16.8	6.3	0.0	11.9
1992	12,218	4,927	161	17,306	1,263	1,478	0	2,741	70.6	28.5	0.9	46.1	53.9		10.3	30.0	0.0	15.8
1993	7,163	6,233	0	13,396	1,681	313	0	1,994	53.5	46.5	0.0	84.3	15.7		23.5	5.0	0.0	14.9
1994	16,606	6,282	228	23,116	759	1,348	0	2,107	71.8	27.2	1.0	36.0	64.0		4.6	21.5	0.0	9.1
1995	11,718	7,695	256	19,669	638	868	4	1,509	59.6	39.1	1.3	42.2	57.5	0.3	5.4	11.3	1.6	7.7
1996	11,077	6,624	0	17,701	1,940	481	0	2,422	62.6	37.4	0.0	80.1	19.9	0.0	17.5	7.3	0.0	13.7
1997	9,088	1,553	0	10,641	465	331	0	796	85.4	14.6	0.0	58.4	41.6	0.0	5.1	21.3	0.0	7.5
1998	32,948	8,344	0	41,292	3,434	1,012	0	4,445	79.8	20.2	0.0	77.2	22.8	0.0	10.4	12.1	0.0	10.8
1999	19,656	4,560	210	24,426	3,018	1,095	0	4,114	80.5	18.7	0.9	73.4	26.6	0.0	15.4	24.0	0.0	16.8
2000	10,440	4,830	334	15,604	3,546	633	-	4,179	66.9	31.0	2.1	84.8	15.2	-	34.0	13.1	-	26.8
2001[a]	24,960	5,949	-	30,909	2,383	-	-	2,383	80.8	19.2	-	100.0	-	-	9.5	-	-	7.7
2002[a]	21,516	-	-	21,516					100.0	-	-							
Avg[b]	17,666	8,719	217	26,602	2,067	1,254	0	3,322	68.0	31.2	0.8	60.4	39.5	0.1	11.5	16.2	0.2	12.0

CWTs

Brood	Smolt Production (by freshwater age)				Adult return (by freshwater age)				Smolts (freshwater age)			Escapement (freshwater age)[c]			Smolt to Adult Return Survival (% by freshwater age)			
Year	Age 2	Age 3	Age 4	Total	Age 2	Age 3	Age 4	Total	% Age 2	%Age 3	%Age 4	% Age 2	%Age 3	%Age 4	Age 2	Age 3	Age 4	Overall
1990	18,000	7,270	205	25,476	402	802	0	1,204	70.7	28.5	0.8	33.4	66.6		2.2	11.0	0.0	4.7
1991	15,379	20,377	711	36,466	1,223	628	0	1,851	42.2	55.9	1.9	66.1	33.9		8.0	3.1	0.0	5.1
1992	8,737	3,849	144	12,730	441	315	0	757	68.6	30.2	1.1	58.3	41.7		5.1	8.2	0.0	5.9
1993	5,596	5,561	0	11,157	359	142	0	500	50.2	49.8	0.0	71.6	28.4		6.4	2.6	0.0	4.5
1994	14,815	4,735	167	19,716	344	272	0	616	75.1	24.0	0.8	55.9	44.1	0.0	2.3	5.7	0.0	3.1
1995	8,831	5,630	233	14,694	128	303	6	437	60.1	38.3	1.6	29.4	69.3	1.3	1.5	5.4	2.4	3.0
1996	8,104	6,033	0	14,137	677	314	0	991	57.3	42.7	0.0	68.3	31.7	0.0	8.4	5.2	0.0	7.0
1997	8,277	1,356	0	9,633	303	204	0	507	85.9	14.1	0.0	59.8	40.2	0.0	3.7	15.0	0.0	5.3
1998	28,776	6,620	0	35,396	2,112	470	0	2,582	81.3	18.7	0.0	81.8	18.2	0.0	7.3	7.1	0.0	7.3
1999	15,596	3,745	184	19,524	1,404	344	0	1,747	79.9	19.2	0.9	80.3	19.7	0.0	9.0	9.2	0.0	9.0
2000	8,573	4,235	309	13,117	1,113	272	-	1,385	65.4	32.3	2.4	80.4	19.6	-	13.0	6.4	-	10.6
2001[a]	21,886	5,509	-	27,395	1,024	-	-	1,024	79.9	20.1	-	100.0	-	-	4.7	-	-	3.7
2002[a]	19,924	-	-	19,924					100.0	-	-							
Avg[b]	12,789	5,310	178	19,277	739	379	1	1,119	67.1	32.1	0.7	60.5	39.4	0.2	5.4	7.2	0.2	5.5

Brood	All fish		CWT's	
Year	smolts/spawner	recruits/spawner	smolts/spawner	recruits/spawner
1990				
1991				
1992	11.1	1.8	8.2	0.5
1993	12.8	1.9	10.6	0.5
1994	9.1	0.8	7.8	0.2
1995	21.7	1.7	16.2	0.5
1996	17.0	2.3	13.6	1.0
1997	22.6	1.7	20.5	1.1
1998	42.7	4.6	36.6	2.7
1999	17.5	3.0	14.0	1.3
2000	34.2	9.2	28.8	3.0
Avg	21.0	3.0	17.4	1.2

[a] (-) Incomplete data for 2001 and 2002, to be completed with data from subsequent returns.

[b] average for "Total" includes years for which complete production data is available.

[c] Age composition of adult escapement return for brood year.

FIGURES

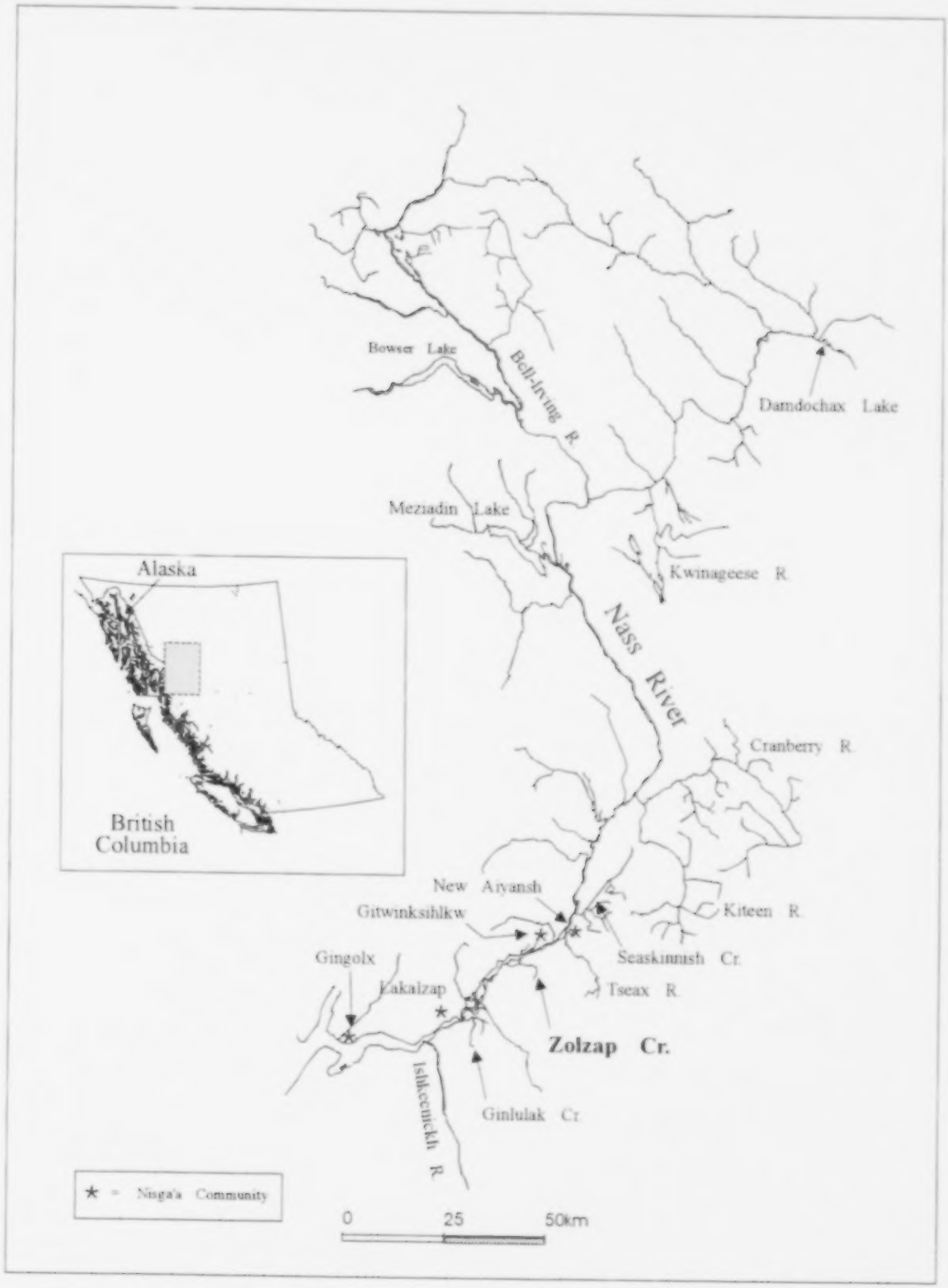

Figure 1. The Nass River watershed, British Columbia.

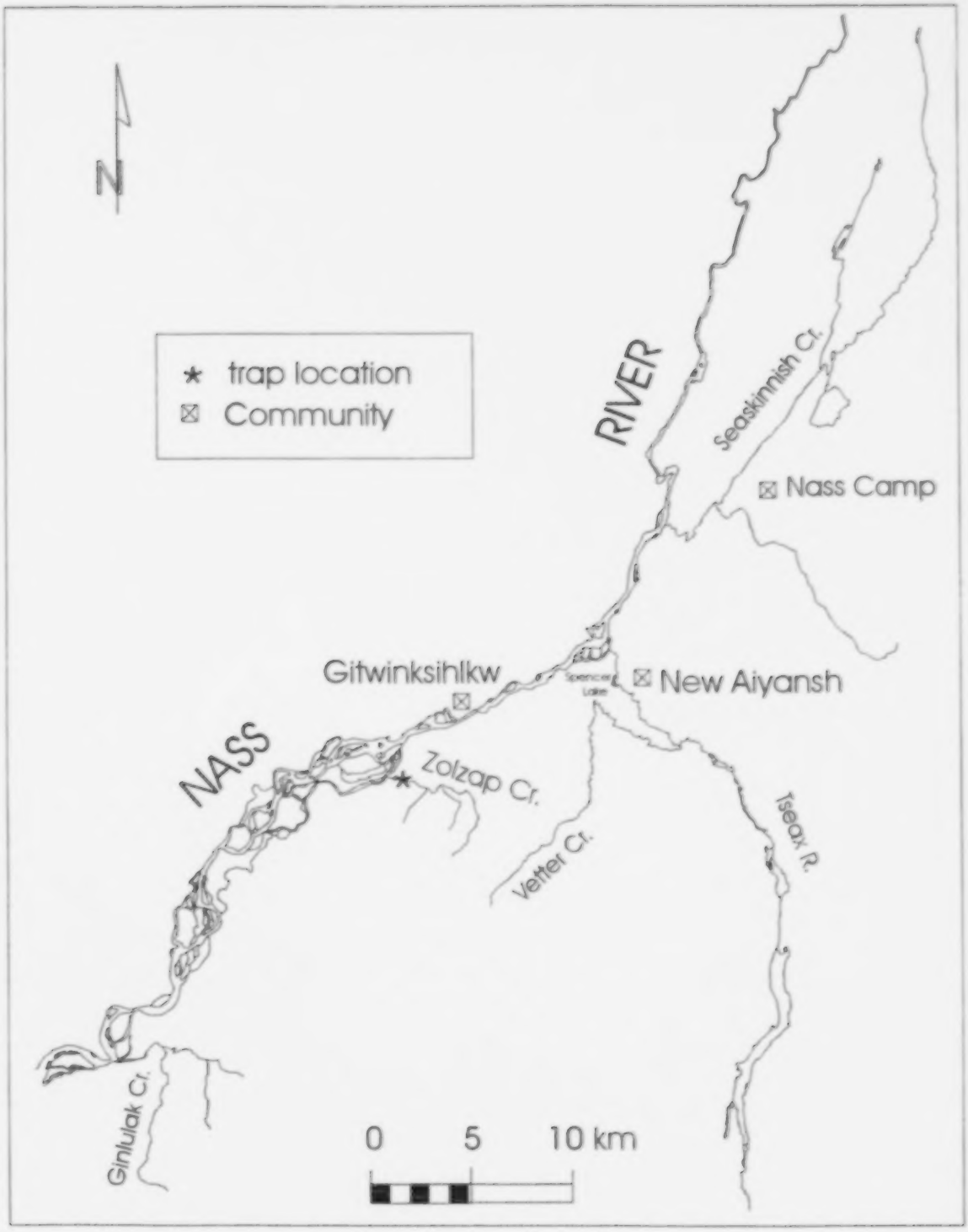

Figure 2. Zolzap Creek and location of enumeration fence.

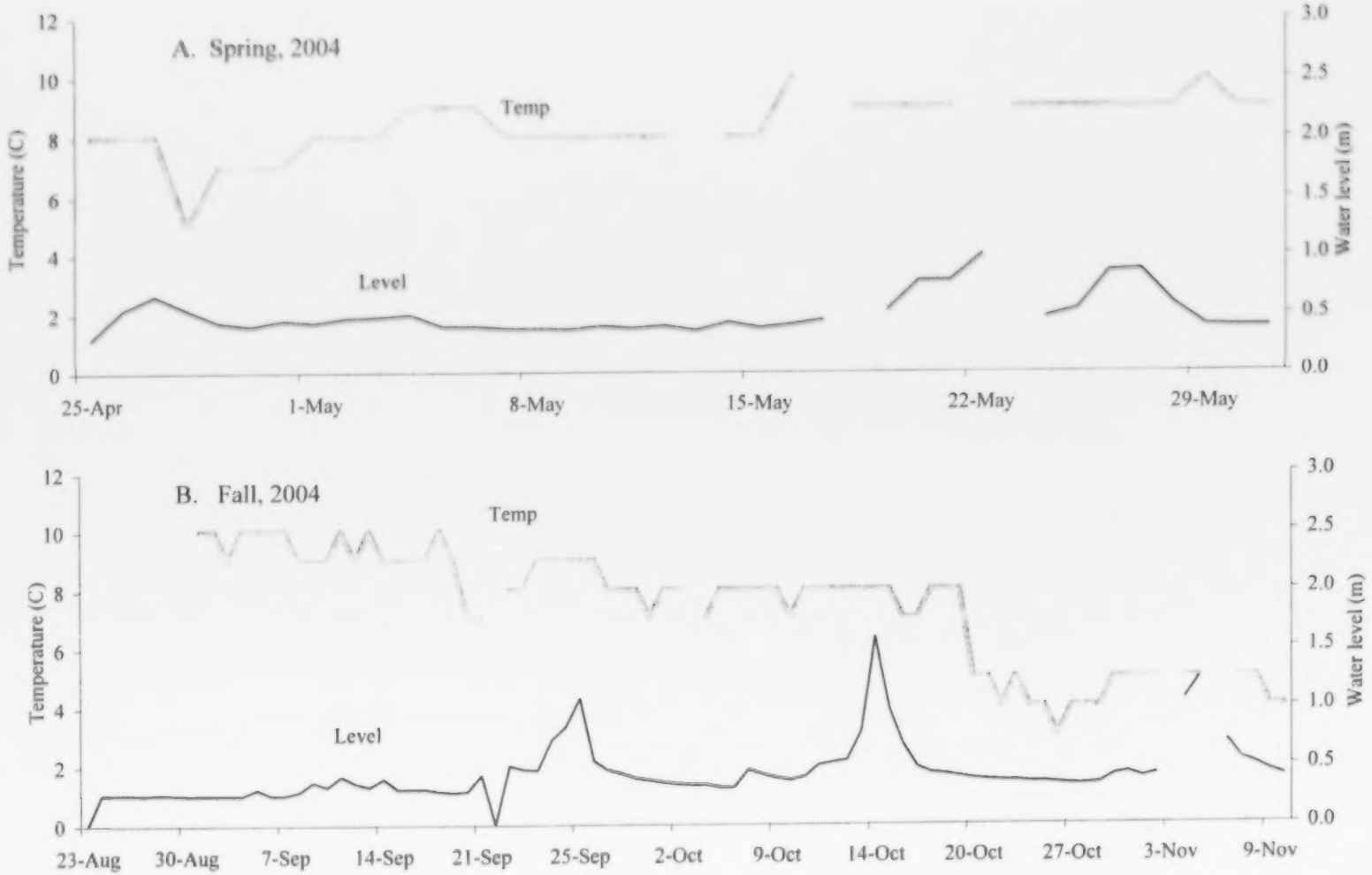

Figure 3. Water level and temperature at Zolzap Creek, 2004.

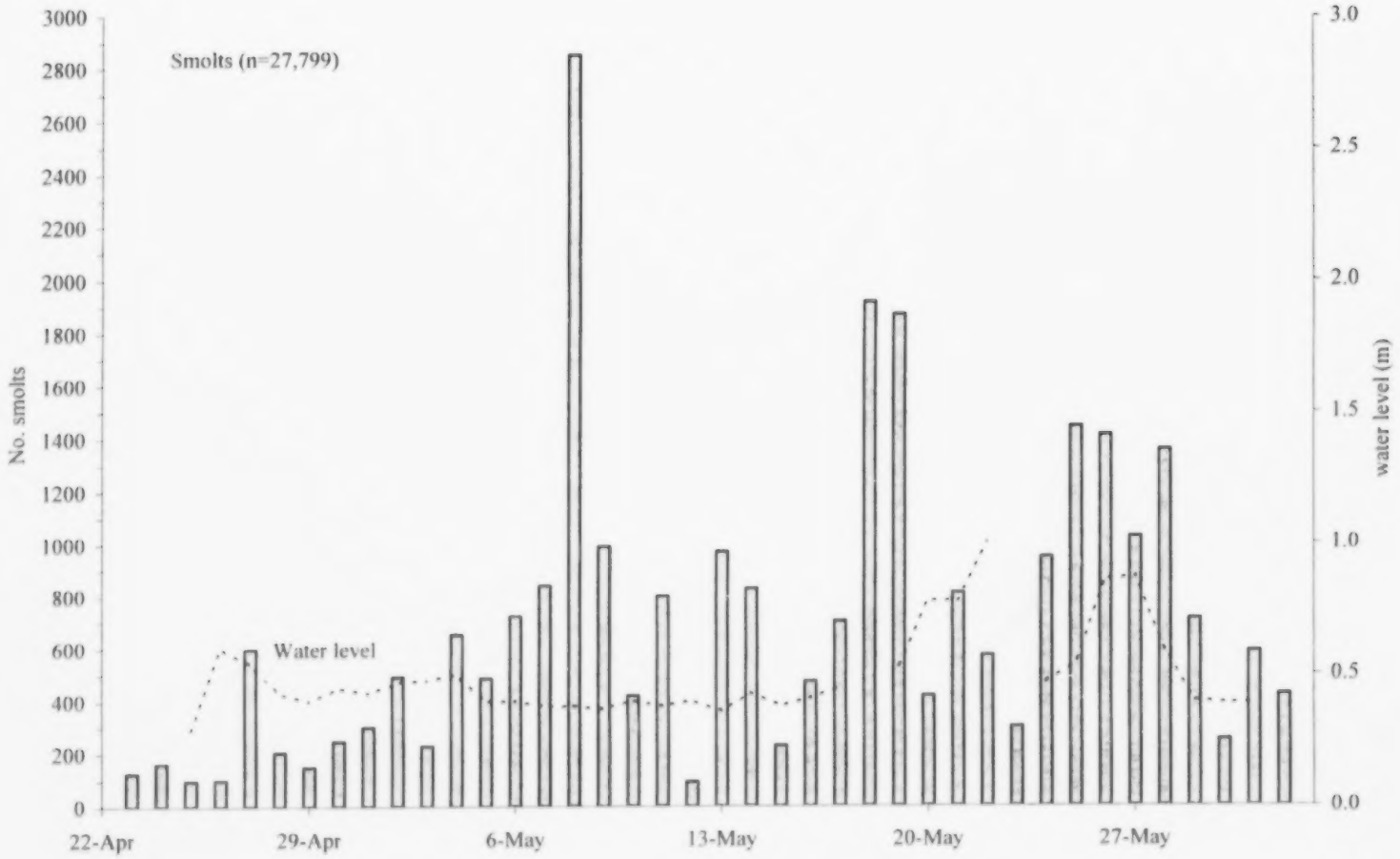

Figure 4. Daily migration of coho smolts at Zolzap Creek, 23 April - 1 June, 2004.

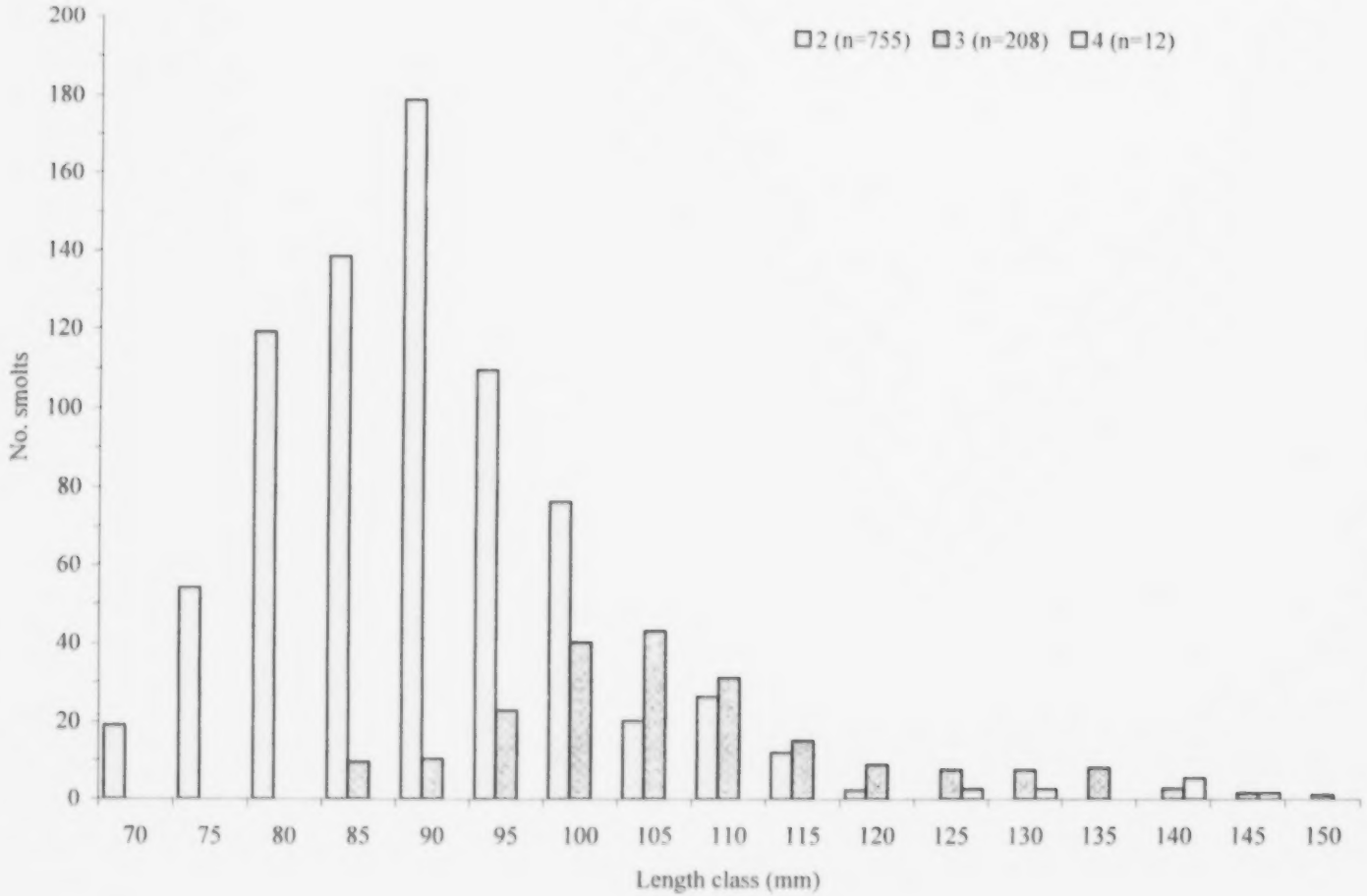

Figure 5. Length-frequency and calculated age distribution of Zolzap Creek coho smolts, 2004.

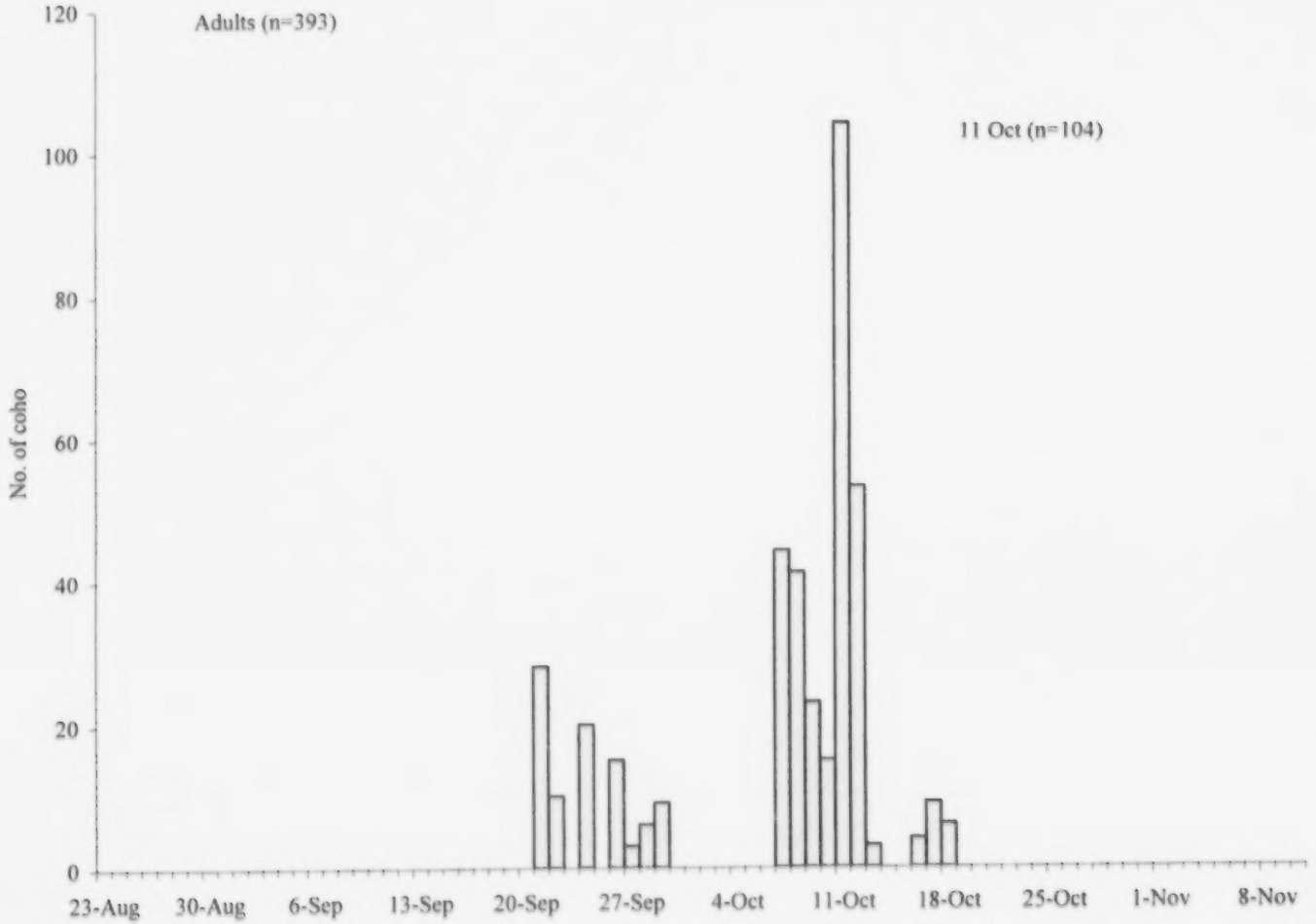

Figure 6. Daily counts of adult coho at the Zolzap Creek enumeration fence, 23 August - 10 November, 2004.

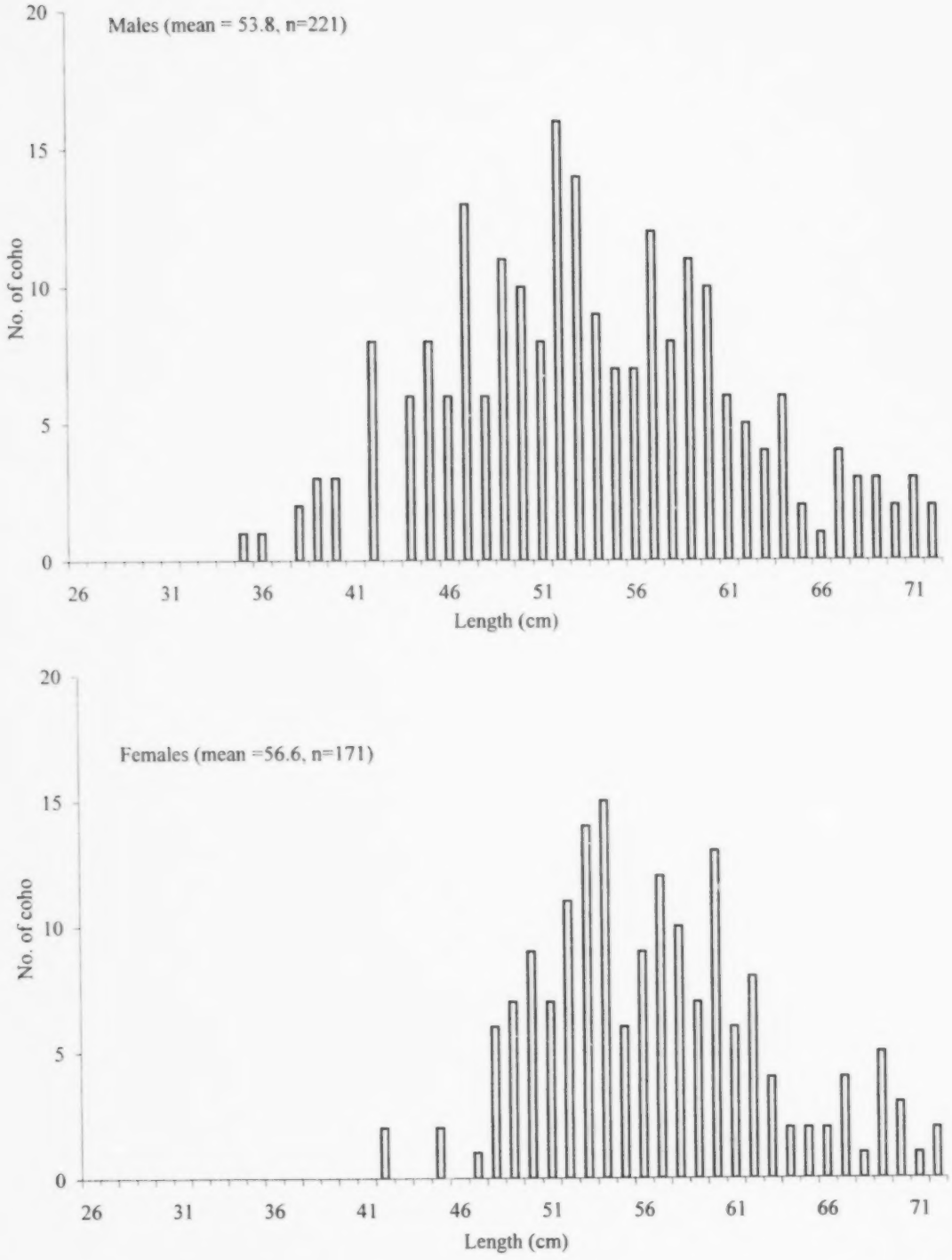

Figure 7. Length-frequency distribution of coho, by sex, Zolzap Creek, 2004.

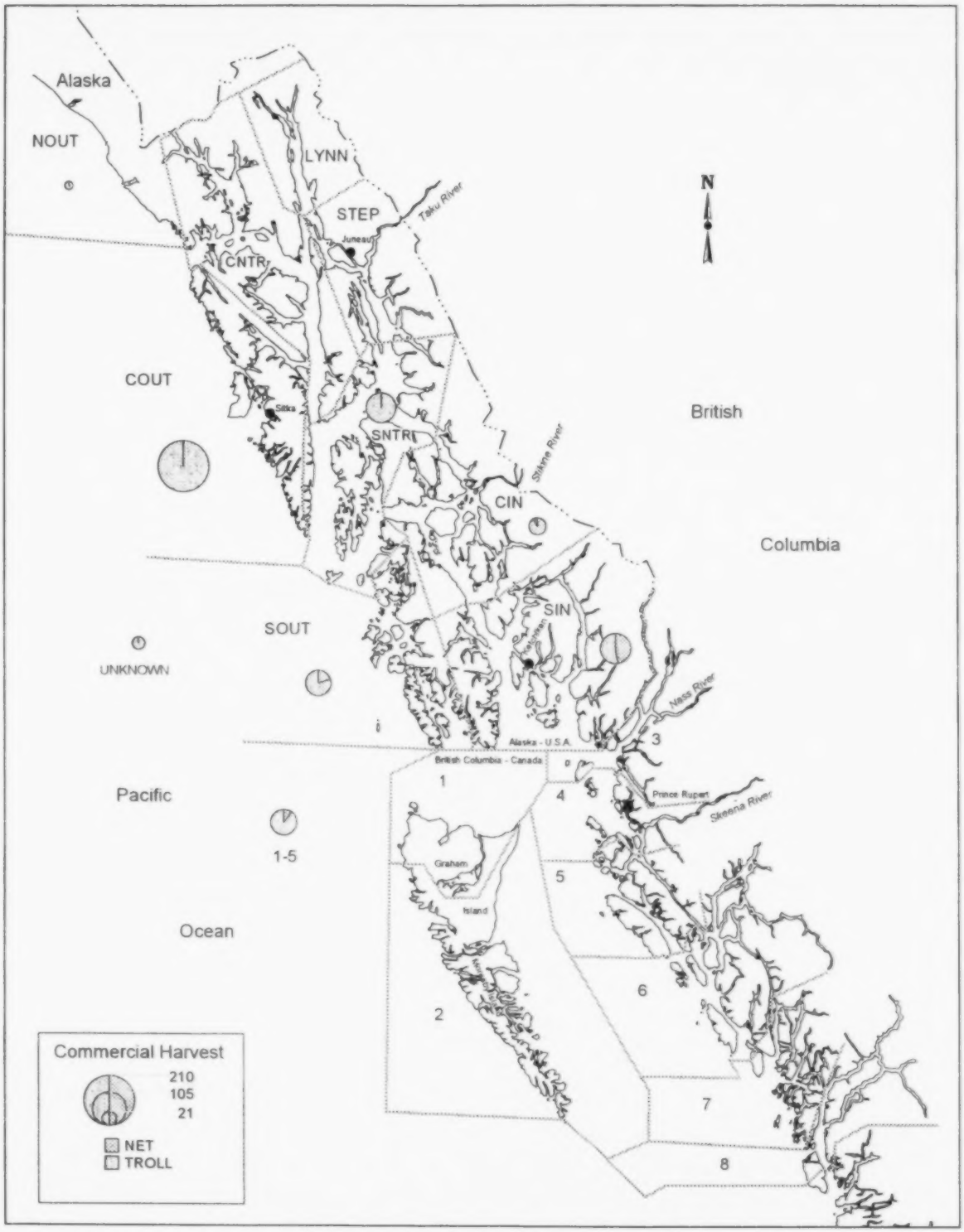

Figure 8. Fisheries Statistical Areas for the north coast of British Columbia and southeast Alaska, and commerical harvest distribution of Zolzap Creek CWT coho, 2004.

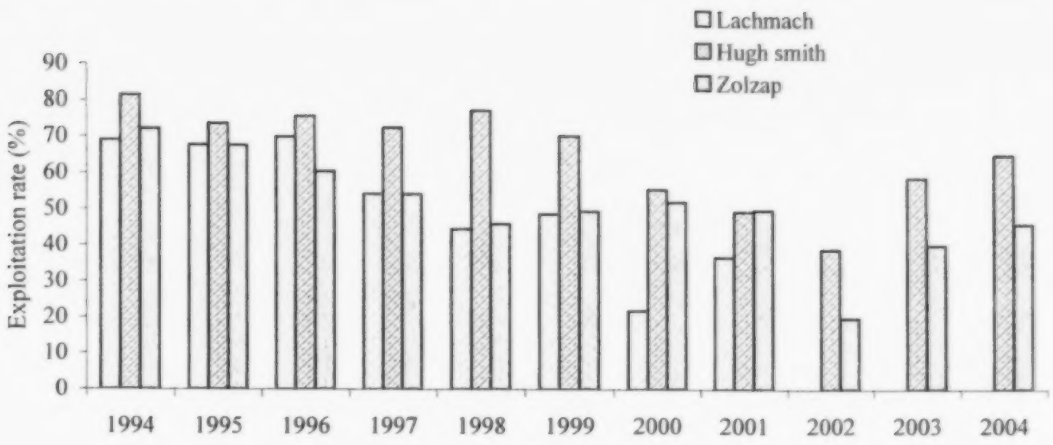

Figure 9. Exploitation rates for three wild coho indicator stocks.

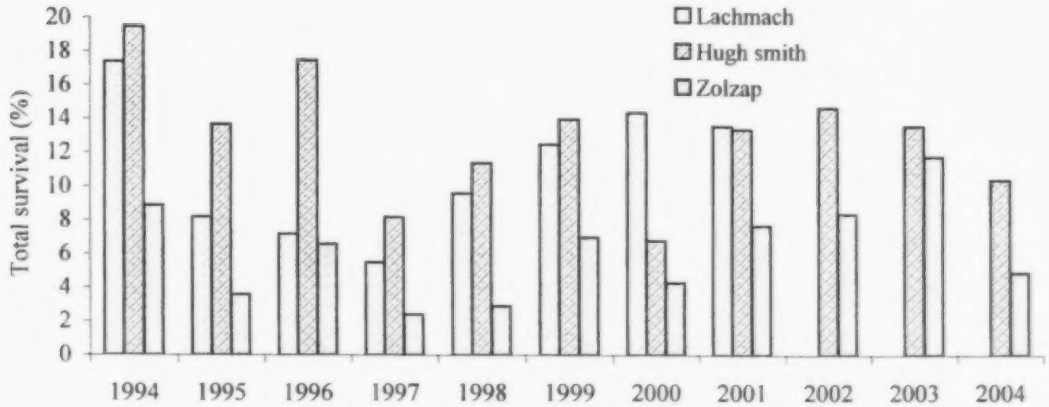

Figure 10. Total percent survivals for three wild coho indicator stocks.

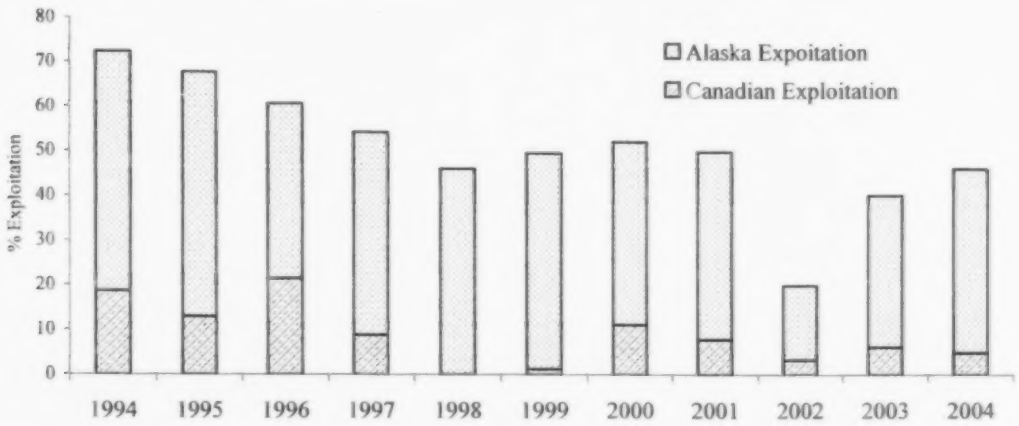

Figure 11. Canadian and Alaskan expoitation rates on Zolzap Creek coho, 1994-2004.

APPENDIX A

Water level and temperature data for Zolzap Creek, 2004

Table A-1. Daily water level and temperature at the spring juvenile and fall adult fences at Zolzap Creek, 2004.

Spring			Fall			Fall		
Date	Gauge Height (m)	Water temp (°C)	Date	Gauge Height (m)	Water temp (°C)	Date	Gauge Height (m)	Water temp (°C)
25-Apr	0.3	8.0	23-Aug			7-Oct	0.5	8.0
26-Apr	0.6	8.0	24-Aug	0.3		8-Oct	0.4	8.0
27-Apr	0.5	5.0	25-Aug	0.3		9-Oct	0.4	8.0
28-Apr	0.4	7.0	26-Aug	0.3		11-Oct	0.5	8.0
29-Apr	0.4	7.0	27-Aug	0.3		12-Oct	0.5	8.0
30-Apr	0.5	7.0	28-Aug	0.3		13-Oct	0.8	8.0
1-May	0.4	8.0	29-Aug	0.3		14-Oct	1.6	8.0
2-May	0.5	8.0	30-Aug	0.3		15-Oct	1.0	8.0
3-May	0.5	8.0	31-Aug	0.3	10.0	16-Oct	0.7	7.0
4-May	0.5	9.0	1-Sep	0.3	10.0	17-Oct	0.5	7.0
5-May	0.4	9.0	2-Sep	0.3	9.0	18-Oct	0.4	8.0
6-May	0.4	9.0	3-Sep	0.3	10.0	19-Oct	0.4	8.0
7-May	0.4	8.0	5-Sep	0.3	10.0	20-Oct	0.4	5.0
8-May	0.4	8.0	6-Sep	0.3	10.0	21-Oct	0.4	5.0
9-May	0.4	8.0	7-Sep	0.3	10.0	22-Oct	0.4	4.0
10-May	0.4	8.0	8-Sep	0.3	9.0	23-Oct	0.4	5.0
11-May	0.4	8.0	9-Sep	0.4	9.0	24-Oct	0.4	4.0
12-May	0.4	8.0	10-Sep	0.3	8.0	25-Oct	0.4	4.0
13-May	0.4		11-Sep	0.4	10.0	26-Oct	0.3	3.0
14-May	0.4	8.0	12-Sep	0.4	9.0	27-Oct	0.3	4.0
15-May	0.4	8.0	13-Sep	0.3	10.0	28-Oct	0.3	4.0
16-May	0.4	10.0	14-Sep	0.4	9.0	29-Oct	0.3	4.0
17-May	0.5		15-Sep	0.3	9.0	30-Oct	0.4	5.0
18-May		9.0	16-Sep	0.3	9.0	31-Oct	0.4	5.0
19-May	0.5	9.0	17-Sep	0.3	9.0	1-Nov	0.4	5.0
20-May	0.8	9.0	18-Sep	0.3	10.0	2-Nov	0.4	5.0
21-May	0.8	9.0	19-Sep	0.3	9.0	3-Nov		
22-May	1.0		20-Sep	0.3	7.0	4-Nov	1.1	5.0
23-May		9.0	21-Sep	0.4	7.0	5-Nov		
24-May	0.5	9.0	22-Sep	0.5	8.0	6-Nov	0.7	
25-May	0.5	9.0	23-Sep	0.5	9.0	7-Nov	0.6	
26-May	0.9	9.0	24-Sep	0.8	9.0	8-Nov	0.5	
27-May	0.9	9.0	25-Sep	1.1	9.0	9-Nov	0.4	
28-May	0.6	9.0	26-Sep	0.5	9.0	10-Nov	0.4	
29-May	0.4	10.0	27-Sep	0.5	8.0			
30-May	0.4	9.0	28-Sep	0.4	8.0			
31-May	0.4	9.0	29-Sep	0.4	8.0			
			30-Sep	0.4	7.0			
			1-Oct	0.4	8.0			
Mean	0.5	8.4	2-Oct	0.3	8.0			
Min	0.3	5.0	3-Oct	0.3		Mean	0.4	7.5
Max	1.0	10.0	4-Oct	0.3	7.0	Min	0.3	3.0
Std Dev	0.2	1.0	5-Oct	0.3	8.0	Max	1.6	10.0
			6-Oct	0.3	8.0	Std Dev	0.2	2.0

APPENDIX B

Daily catch at the Zolzap Creek spring juvenile fence, 2004

Table B-1. Juvenile coho catch at Zolzap Creek enumeration fence, 2004.

Date	fry/presmolts	smolts	morts
23-Apr	0	126	0
24-Apr	4	161	0
25-Apr	6	98	0
26-Apr	3	100	0
27-Apr	15	597	0
28-Apr	6	205	0
29-Apr	4	148	0
30-Apr	16	247	0
1-May	8	300	0
2-May	9	492	0
3-May	50	228	0
4-May	26	653	0
5-May	27	487	2
6-May	64	723	0
7-May	13	839	0
8-May	12	2,850	0
9-May	15	988	0
10-May	9	420	0
11-May	70	798	0
12-May	0	92	0
13-May	22	968	0
14-May	0	827	0
15-May	1	229	0
16-May	2	474	0
17-May	6	702	0
18-May	3	1,916	0
19-May	3	1,869	1
20-May	0	419	0
21-May	7	810	0
22-May	0	572	0
23-May	2	300	0
24-May	7	947	0
25-May	9	1,445	0
26-May	34	1,414	0
27-May	14	1,025	0
28-May	5	1,358	0
29-May	4	710	0
30-May	0	250	0
31-May	5	587	0
1-Jun	0	425	0
2-Jun	0	0	0
Total	481	27,799	3

Table B-2. Non-coho catch at Zolzap Creek spring enumeration fence, 2004.

Date	Steelhead		Cutthroat		D. Varden		Sockeye	Chum			
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Juvenile	Cottid	Lamprey	Stickleback
23-Apr	0	0	3	0	8	0	0	0	4	21	6
24-Apr	0	0	0	0	21	0	0	0	0	12	0
25-Apr	2	0	1	0	17	0	0	1	9	14	2
26-Apr	0	0	0	0	16	0	0	0	5	32	2
27-Apr	2	0	2	2	51	7	1	0	4	21	3
28-Apr	3	0	0	0	25	3	0	0	4	6	9
29-Apr	5	0	0	2	49	9	0	1	6	0	16
30-Apr	3	0	0	2	29	11	0	0	1	19	27
1-May	1	0	1	1	29	1	1	0	4	10	15
2-May	0	0	0	0	10	0	0	0	2	2	4
3-May	0	0	0	0	21	0	0	0	1	3	1
4-May	1	0	0	1	4	0	0	0	0	3	2
5-May	0	0	0	0	2	0	0	0	0	1	0
6-May	0	0	2	1	14	0	0	0	4	3	2
7-May	3	0	1	0	23	0	1	0	0	1	1
8-May	3	0	2	2	61	0	0	0	3	4	0
9-May	1	0	0	1	35	0	0	0	0	8	2
10-May	0	0	0	2	19	2	0	0	1	7	0
11-May	0	0	0	0	6	0	0	0	2	7	0
12-May	0	0	0	0	8	0	0	0	0	6	0
13-May	1	0	0	0	36	0	0	0	1	18	5
14-May	0	0	1	3	32	0	0	0	1	10	3
15-May	0	0	0	0	2	0	0	0	0	5	0
16-May	0	0	0	0	9	0	0	0	0	4	0
17-May	0	1	1	0	1	0	0	0	0	0	0
18-May	2	0	2	0	8	0	0	0	0	5	1
19-May	0	0	0	0	6	0	0	0	0	3	1
20-May	0	0	0	1	0	0	0	0	0	4	0
21-May	0	0	0	0	2	0	0	0	1	0	0
22-May	0	0	0	0	0	0	0	0	0	2	0
23-May	0	0	0	0	8	0	0	0	0	6	2
24-May	0	0	0	0	3	0	0	0	0	3	1

Table B-2. Non-coho catch at Zolzap Creek spring enumeration fence, 2004.

Date	Steelhead		Cutthroat		D. Varden		Sockeye	Chum			
	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Juvenile	Cottid	Lamprey	Stickleback
25-May	1	1	0	11	19	7	1	0	0	6	0
26-May	0	0	0	0	1	0	0	0	0	2	1
27-May	0	0	1	0	3	0	0	0	0	2	0
28-May	0	0	1	1	14	1	0	0	1	8	1
29-May	0	0	0	0	3	0	0	0	0	10	0
30-May	0	0	1	0	2	0	0	0	0	2	0
31-May	0	0	0	3	10	2	0	0	0	6	2
1-Jun	0	0	0	0	1	0	0	0	0	12	0
Total	28	2	19	33	608	43	4	2	54	288	109

APPENDIX C

Coded-wire tagging data for Zolzap Creek, 2004

Table C-1. Coded-wire tagging data for coho smolts at Zolzap Creek, 2004.

Date	Total smolts	Fence morts	Tag code	No. AFC	Tag morts	No. rlsd. untagged	No. rlsd. AFC
23-Apr	126	0	-	0	0	126	0
24-Apr	161	30	-	0	0	6	0
25-Apr	98	3	-	0	0	0	0
26-Apr	100	3	28-01-13	316	5	0	311
27-Apr	597	94	28-01-13	412	5	90	407
28-Apr	205	4	28-01-13	201	5	0	196
29-Apr	148	1	-	0	0	0	0
30-Apr	247	0	28-01-13	388	3	4	385
1-May	300	3	-	0	0	0	0
2-May	492	7	-	0	0	0	0
3-May	228	7	28-01-13	996	7	7	989
4-May	653	0	-	0	0	0	0
5-May	487	1	28-01-13	1,135	4	4	1,131
6-May	723	0	-	0	0	0	0
7-May	839	34	28-01-13	1,505	5	23	1,500
8-May	2,850	289	28-01-13	2,441	4	120	2,437
9-May	988	0	28-01-13	977	4	11	973
10-May	420	0	28-01-13	417	2	3	415
11-May	798	0	-	0	0	0	0
12-May	92	0	28-01-13	881	4	9	877
13-May	968	4	28-01-14	930	3	33	927
14-May	827	17	28-01-14	800	4	10	796
15-May	229	2	-	0	0	0	0
16-May	474	0	28-01-14	680	3	21	677
17-May	702	0	28-01-14	697	3	5	693
18-May	1,916	0	28-01-14	1,849	5	62	1,844
19-May	1,869	2	28-01-14	1,790	3	80	1,787
20-May	419	0	-	0	0	0	0
21-May	810	2	28-01-14	1,217	2	10	1,215
22-May	372	0	-	0	0	0	0
23-May	300	0	28-01-14	862	3	10	859
24-May	947	0	28-01-14	928	5	20	923
25-May	1,445	3	28-01-14	1,393	4	53	1,389
26-May	1,414	3	28-01-15	1,399	3	12	1,396
27-May	1,025	4	28-01-15	1,007	4	14	1,003
28-May	1,358	2	28-01-15	1,311	6	45	1,305
29-May	710	0	28-01-15	702	2	8	700
30-May	250	0	-	0	0	0	0
31-May	587	0	28-01-15	793	3	44	790
1-Jun	425	0	-	0	0	425	0
2-Jun	0	0	-	0	0	0	0
Total	27,799	515	-	26,027	101	1,255	25,925

APPENDIX D

Schematic of Adult Fence and Daily counts of adult coho at Zolzap Creek, 2004

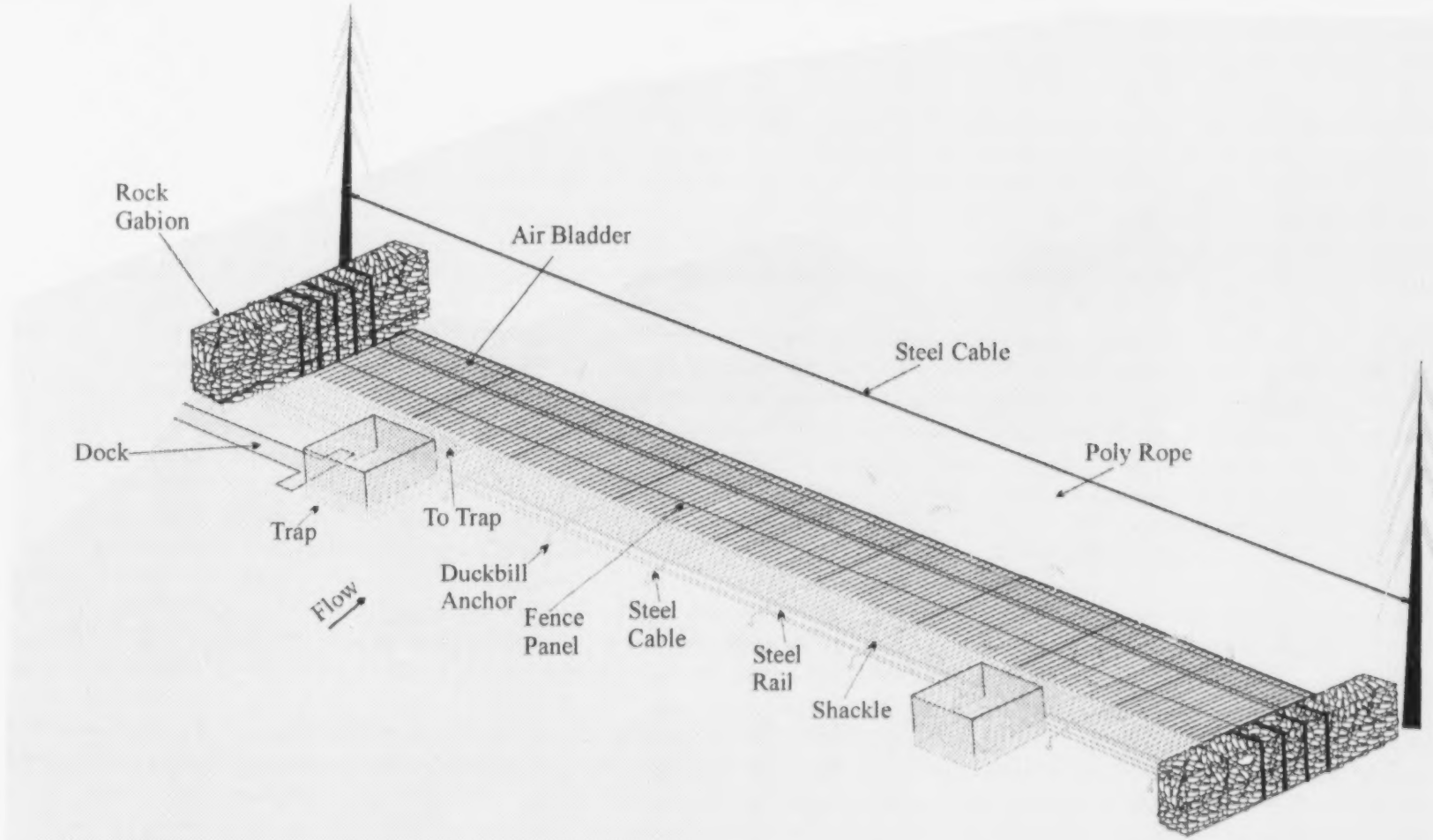

Figure D-1. Floating fence used at Zolzap Creek in 2004. (Schematic not to scale)

Table D-1. Daily counts of adult coho at Zolzap Creek enumeration fence, 2004.

Date	No. examined	No. operculum tagged
21-Sep	28	28
22-Sep	10	10
23-Sep		
24-Sep	20	20
25-Sep		
26-Sep	15	15
27-Sep	3	3
28-Sep	6	6
29-Sep	9	9
30-Sep		
1-Oct		
2-Oct		
3-Oct		
4-Oct		
5-Oct		
6-Oct		
7-Oct	44	44
8-Oct	41	41
9-Oct	23	23
10-Oct	15	15
11-Oct	104	103
12-Oct	53	53
13-Oct	3	3
14-Oct		
15-Oct		
16-Oct	4	4
17-Oct	9	9
18-Oct	6	6
Totals	393	392

APPENDIX E

Upstream mark-recovery survey information at Zolzap Creek, 2004

Table E-1. Upstream coho mark-recovery survey information for Zolzap Creek, 2004.

Fish No.	Date Recovered	Location Recovered	Rec. Type (L,D,A,N)[1]	Sex (M/F)	AFC (Y/N)	Operculum Tag Number	Date Tagged at Fence	Rec. Type Tag (T,UT,MT)[2]	Recap (1, 2)[3]	Residence Time
1	10-Oct	Zolzap Fence	D	M	N			UT	1	
2	12-Oct	Zolzap Fence	D	M	N	13253	11-Oct	T	1	1
3	12-Oct	Zolzap Fence	D	M	N	13315	11-Oct	T	1	1
4	16-Oct	Goat Creek	L	F	Y			UT	1	
5	16-Oct	Goat Creek	L	F	N			UT	1	
6	16-Oct	Goat Creek	L	F	N			UT	1	
7	16-Oct	Goat Creek	L	M	Y	13132	7-Oct	T	1	9
8	16-Oct	Goat Creek	L	M	N			UT	1	
9	16-Oct	Goat Creek	L	F	Y	13154	8-Oct	T	1	8
10	16-Oct	Goat Creek	L	M	N	13223	11-Oct	T	1	5
11	16-Oct	Goat Creek	L	F	Y			UT	1	
12	16-Oct	Goat Creek	L	F	N			UT	1	
13	16-Oct	Goat Creek	L	F	Y			UT	1	
14	16-Oct	Goat Creek	L	F	N			UT	1	
15	16-Oct	Goat Creek	L	M	N			UT	1	
16	16-Oct	Goat Creek	L	F	Y			UT	1	
17	16-Oct	Goat Creek	L	F	Y			UT	1	
18	16-Oct	Goat Creek	L	M	Y			UT	1	
19	16-Oct	Goat Creek	L	M	N			UT	1	
20	16-Oct	Goat Creek	L	M	Y			UT	1	
21	16-Oct	Goat Creek	L	M	Y			UT	1	
22	16-Oct	Goat Creek	L	M	Y			UT	1	
23	16-Oct	Goat Creek	L	M	N			UT	1	
24	16-Oct	Goat Creek	L	F	Y	13014	21-Sep	T	1	25
25	16-Oct	Goat Creek	L	M	Y			UT	1	
26	16-Oct	Goat Creek	L	F	Y			UT	1	
27	16-Oct	Goat Creek	L	M	Y			UT	1	
28	16-Oct	Goat Creek	L	M	Y			UT	1	
29	16-Oct	Goat Creek	L	M	Y			UT	1	
30	16-Oct	Goat Creek	L	M	Y			UT	1	
31	16-Oct	Goat Creek	L	M	Y			UT	1	
32	16-Oct	Goat Creek	L	M	N			UT	1	
33	16-Oct	Goat Creek	L	M	N			UT	1	
34	16-Oct	Goat Creek	L	F	Y			UT	1	
35	16-Oct	Goat Creek	L	M	Y			UT	1	
36	16-Oct	Goat Creek	L	M	N	13053	24-Sep	T	1	22
37	16-Oct	Goat Creek	L	M	N			UT	1	
38	16-Oct	Goat Creek	L	M	Y			UT	1	
39	16-Oct	Goat Creek	L	M	N			UT	1	
40	16-Oct	Goat Creek	L	M	Y	13240	11-Oct	T	1	5
41	16-Oct	Goat Creek	L	F	Y	13193	9-Oct	T	1	7
42	16-Oct	Goat Creek	L	M	Y	13064	26-Sep	T	1	20
43	16-Oct	Goat Creek	L	F	N			UT	1	
44	16-Oct	Goat Creek	L	M	Y			UT	1	
45	16-Oct	Goat Creek	L	F	N	13045	24-Sep	T	1	22
46	16-Oct	Goat Creek	L	F	N			UT	1	
47	16-Oct	Goat Creek	L	F	Y			UT	1	

Table E-1. Upstream coho mark-recovery survey information for Zolzap Creek, 2004.

Fish No.	Date Recovered	Location Recovered	Rec. Type (L,D,A,N)[1]	Sex (M/F)	AFC (Y/N)	Operculum Tag Number	Date Tagged at Fence	Rec. Type Tag (T,UT,MT)[2]	Recap (1, 2)[3]	Residence Time
48	16-Oct	Goat Creek	L	M	Y			UT	1	
49	16-Oct	Goat Creek	L	M	Y			UT	1	
50	17-Oct	Zolzap Fence	D	M	N			UT	1	
51	17-Oct	Zolzap Fence	D	F	N			UT	1	
52	18-Oct	Zolzap Fence	D	M	N	13403	17-Oct	T	1	1
53	18-Oct	Zolzap Fence	D	M	N	13396	17-Oct	T	1	1
54	19-Oct	Upper Head	L	F	Y			UT	1	
55	19-Oct	Upper Head	L	M	N			UT	1	
56	19-Oct	Upper Head	D	M	Y			UT	1	
57	19-Oct	Upper Head	D	M	Y	13264	11-Oct	T	1	8
58	19-Oct	Upper Head	D	M	N			UT	1	
59	30-Oct	Zolzap Fence	D	M	N			UT	1	
60	30-Oct	Zolzap Fence	D	F	Y			UT	1	
61	30-Oct	Zolzap Fence	L	M	N			UT	1	
62	30-Oct	Zolzap Fence	D	F	N			UT	1	
63	30-Oct	Zolzap Fence	D	M	N			UT	1	
64	31-Oct	Goat Creek	L	F	Y			UT	1	
65	31-Oct	Goat Creek	L	M	N	13223	11-Oct	T	2	20
66	31-Oct	Goat Creek	L	M	N			UT	1	
67	31-Oct	Goat Creek	L	M	N			UT	1	
68	31-Oct	Goat Creek	L	M	N			UT	1	
69	31-Oct	Goat Creek	L	M	Y			UT	1	
70	31-Oct	Goat Creek	L	F	N					
71	31-Oct	Goat Creek	L	M	N			UT	1	
72	31-Oct	Goat Creek	L	F	N	13066	26-Sep	T	1	35
73	31-Oct	Goat Creek	L	M	N			UT	1	
74	31-Oct	Goat Creek	L	M	N			UT	1	
75	31-Oct	Goat Creek	L	F	N			UT	1	
76	31-Oct	Goat Creek	L	M	N	13171	8-Oct	T	1	23
77	31-Oct	Goat Creek	L	F	Y	13096	7-Oct	T	1	24
78	31-Oct	Goat Creek	L	M	N	13124	7-Oct	T	1	24
79	31-Oct	Goat Creek	L	M	N	13079	28-Sep	T	1	33
80	31-Oct	Goat Creek	L	M	N			UT	1	
81	31-Oct	Goat Creek	L	M	Y			UT	1	
82	31-Oct	Goat Creek	L	M	Y			UT	1	
83	31-Oct	Goat Creek	L	M	Y	13087	29-Sep	T	1	32
84	31-Oct	Goat Creek	L	M	N			UT	1	
85	31-Oct	Goat Creek	L	M	N			UT	1	
86	31-Oct	Goat Creek	L	M	N			UT	1	
87	31-Oct	Goat Creek	L	M	N			UT	1	
88	31-Oct	Goat Creek	L	F	N	13152	8-Oct	T	1	23
89	31-Oct	Goat Creek	L	F	N			UT	1	
90	31-Oct	Goat Creek	L	F	N			UT	1	
91	31-Oct	Goat Creek	L	M	Y	13084	29-Sep	T	1	32
92	31-Oct	Goat Creek	L	M	Y			UT	1	
93	31-Oct	Goat Creek	L	M	N			UT	1	
94	31-Oct	Goat Creek	L	M	N	13259	11-Oct	T	1	20

Table E-1. Upstream coho mark-recovery survey information for Zolzap Creek, 2004.

Fish No.	Date Recovered	Location Recovered	Rec. Type (L,D,A,N)[1]	Sex (M/F)	AFC (Y/N)	Operculum Tag Number	Date Tagged at Fence	Rec. Type Tag (T,UT,MT)[2]	Recap (1, 2)[3]	Residence Time
95	31-Oct	Goat Creek	L	M	N			UT	2	
96	31-Oct	Goat Creek	L	M	N			UT	1	
97	31-Oct	Goat Creek	L	M	Y	13239	11-Oct	T	1	20
98	31-Oct	Goat Creek		M	Y			UT	1	
99	31-Oct	Goat Creek		M	N			T	1	
100	31-Oct	Goat Creek	L	F	Y	13214	10-Oct	T	1	21
101	31-Oct	Goat Creek	L	F	N	13349	12-Oct	T	1	19
102	31-Oct	Goat Creek	L	M	Y			UT	1	
103	31-Oct	Goat Creek	L	F	N			UT	2	
104	31-Oct	Goat Creek	L	F		13237	11-Oct	T	1	20
105	31-Oct	Goat Creek	L	M	Y			UT	1	
106	31-Oct	Goat Creek	L	M	Y			UT	1	
107	31-Oct	Goat Creek	L	F	N	13121	7-Oct	T	1	24
108	31-Oct	Goat Creek	L	F	Y			UT	1	
109	31-Oct	Goat Creek	L	F	N			UT	1	
110	31-Oct	Goat Creek	L	M	N			UT	1	
111	31-Oct	Goat Creek	D	M	N			UT	1	
112	31-Oct	Goat Creek	L	M	N			UT	1	
113	31-Oct	Goat Creek	L	F	N	13385	12-Oct	T	1	19
114	31-Oct	Goat Creek	L	M	Y			UT	2	
115	31-Oct	Goat Creek	L	M	Y			UT	1	
116	31-Oct	Goat Creek	L	M	Y			UT	1	
117	31-Oct	Goat Creek	L	M	N	13287	11-Oct	T	1	20
118	31-Oct	Goat Creek	L	M	Y			UT	1	
119	31-Oct	Goat Creek	D	M	Y	13109	7-Oct	T	1	24
120	31-Oct	Zolzap Fence	D	M	N			UT	1	
121	31-Oct	Zolzap Fence	D	M	N			UT	1	
122	31-Oct	Zolzap Fence	D	F	N			UT	1	
123	31-Oct	Zolzap Fence	D	F	Y			UT	2	
124	1-Nov	Upper Head	L	M	N	13303	11-Oct	T	1	21
125	1-Nov	Upper Head	D	M	N					
126	1-Nov	Upper Head	L					UT	1	
127	1-Nov	Upper Head	L	M	N			T	1	
128	1-Nov	Upper Head	L	F	Y			UT	1	
129	1-Nov	Upper Head	D	M	Y					
130	1-Nov	Upper Head	L	F	Y			UT	1	
131	1-Nov	Upper Head	L	M	N			UT	1	
132	1-Nov	Upper Head	L	M	N			UT	1	
133	1-Nov	Upper Head	D	M	N	13209	10-Oct	T	1	22
134	1-Nov	Upper Head	L	M	N			UT	1	
135	1-Nov	Upper Head	L	F	Y			UT	1	
136	1-Nov	Upper Head	L	M	N	13157	8-Oct	T	1	24
137	1-Nov	Upper Head	L	M	N			UT	1	
138	1-Nov	Upper Head	L	M	N	13027	22-Sep	T	1	40
139	1-Nov	Upper Head	L	M	N			UT	1	
140	1-Nov	Upper Head	L	M	N			UT	1	
141	1-Nov	Upper Head	L	M	N			UT	1	

Table E-1. Upstream coho mark-recovery survey information for Zolzap Creek, 2004.

Fish No.	Date Recovered	Location Recovered	Rec. Type (L,D,A,N)[1]	Sex (M/F)	AFC (Y/N)	Operculum Tag Number	Date Tagged at Fence	Rec. Type Tag (T,UT,MT)[2]	Recap (1, 2)[3]	Residence Time
142	1-Nov	Upper Head	L	F	Y	13051	24-Sep	T	1	38
143	1-Nov	Upper Head	L	M	N			UT	1	
144	1-Nov	Upper Head	L	F	Y			UT	1	
145	1-Nov	Upper Head	L	F	Y	13158	8-Oct	T	1	24
146	1-Nov	Upper Head	L	M	N			UT	1	
147	1-Nov	Upper Head	D	M	Y			UT	1	
148	1-Nov	Upper Head	L	F	N	13269	11-Oct	T	1	21
149	1-Nov	Upper Head	L	F	N			UT	1	
150	1-Nov	Upper Head	L	F	Y			UT	1	
151	1-Nov	Zolzap Fence	D	M	N			UT	1	
152	1-Nov	Zolzap Fence	D	M	N			UT	1	
153	1-Nov	Zolzap Fence	D	F	N			UT	1	
154	2-Nov	Reach 7A	L	F	N			UT	1	
155	2-Nov	Reach 7A	L	F	Y			UT	1	
156	2-Nov	Reach 7A	L	M	N			UT	1	
157	2-Nov	Reach 7A	D	M	N	13194	9-Oct	T	1	24
158	2-Nov	Reach 7A	L	M	Y	13291	11-Oct	T	1	22
159	2-Nov	Reach 7A	L	M	N			UT	1	
160	2-Nov	Reach 7A	L	M	Y			UT	1	
161	2-Nov	Reach 7A	L	M	Y			UT	1	
162	2-Nov	Reach 7A	L	M	Y			UT	1	
163	2-Nov	Reach 7A	L	F	N			UT	1	
164	2-Nov	Reach 7A	L	M	Y			UT	1	
165	2-Nov	Reach 7A	L	M	N			UT	1	
166	9-Nov	Goat Creek	L	M	Y			UT	1	
167	9-Nov	Goat Creek	L	M	N	13152	8-Oct	T	2	32
168	9-Nov	Goat Creek	L	M	N			UT	1	
169	9-Nov	Goat Creek	L	F	N			UT	1	
170	9-Nov	Goat Creek	L	M	N			UT	1	
171	9-Nov	Goat Creek	L	M	N			UT	2	
172	9-Nov	Goat Creek	L	M	Y			UT	1	
173	9-Nov	Goat Creek	L	F	Y			UT	1	
174	9-Nov	Goat Creek	L	M	Y			UT	2	
175	9-Nov	Goat Creek	L	M	Y			UT	2	
176	12-Nov	Upper Head	D	M	N			UT	2	
177	12-Nov	Upper Head	D	M	N			UT	2	
178	12-Nov	Upper Head	L	F	N			UT	1	
179	12-Nov	Upper Head	L	M	N			UT	1	
180	12-Nov	Upper Head	D	M	N	13275	11-Oct	T	1	32
181	12-Nov	Upper Head	D	M	Y			UT	1	
182	12-Nov	Upper Head	L	F	N			UT	1	
183	12-Nov	Upper Head	L	M	N			UT	1	
184	12-Nov	Upper Head	L	M	N			UT	1	
185	12-Nov	Upper Head	D	F	Y			UT	2	
186	12-Nov	Upper Head	L	F	N			UT	1	
187	12-Nov	Upper Head	L	F	N			UT	1	
188	12-Nov	Upper Head	L	M	Y			UT	1	

Table E-1. Upstream coho mark-recovery survey information for Zolzap Creek, 2004.

Fish No.	Date Recovered	Location Recovered	Rec. Type (L,D,A,N)[1]	Sex (M/F)	AFC (Y/N)	Operculum Tag Number	Date Tagged at Fence	Rec. Type Tag (T,UT,MT)[2]	Recap (1, 2)[3]	Residence Time
189	12-Nov	Upper Head	L	F	N			UT	1	
190	12-Nov	Upper Head	L	M	Y			UT	1	
191	12-Nov	Upper Head	D	F	Y			UT	1	
192	12-Nov	Upper Head	L	M	N			UT	2	
193	12-Nov	Upper Head	L	F	Y			UT	1	
194	12-Nov	Upper Head	L	M	N			UT	1	
195	12-Nov	Upper Head	L	M	N			UT	2	
196	12-Nov	Upper Head	L	F	Y			UT	1	
197	12-Nov	Upper Head	L	F	N			UT	1	
198	12-Nov	Upper Head	L	M	N			UT	2	
199	12-Nov	Upper Head	L	F	N			UT	1	
200	12-Nov	Upper Head	L	F	N			UT	1	
201	12-Nov	Upper Head	L	M	N			UT	1	
202	12-Nov	Upper Head	L	M	Y	13247	11-Oct	T	1	32
203	12-Nov	Upper Head	L	F	Y			UT	1	
204	12-Nov	Upper Head	L	M	Y	13085	29-Sep	T	1	44
205	12-Nov	Upper Head	L	M	Y			UT	1	
206	12-Nov	Upper Head	L	M	N			UT	1	
207	12-Nov	Upper Head	L	F	N			UT	1	
208	12-Nov	Upper Head	L	M	N			UT	1	
209	12-Nov	Upper Head	L	F	N			UT	1	
210	12-Nov	Upper Head	L	M	N	13229	11-Oct	T	1	32
211	12-Nov	Upper Head	L	M	Y			UT	2	
212	12-Nov	Upper Head	L	F	Y			UT	1	
213	12-Nov	Upper Head	L	M	N	13307	11-Oct	T	1	32
214	12-Nov	Upper Head	L	F	Y			UT	1	
215	12-Nov	Upper Head	D	M	N			UT	1	
216	12-Nov	Upper Head	L	F	N			UT	1	
217	12-Nov	Upper Head	L	F	Y			MT	1	
218	12-Nov	Upper Head	L	F	Y	13051	24-Sep	T	2	49
219	12-Nov	Upper Head	L	M	Y			UT	1	
220	12-Nov	Upper Head	L	M	N			UT	1	
221	12-Nov	Upper Head	L	M	N			UT	2	
222	12-Nov	Upper Head	L	M	Y			UT	1	
223	12-Nov	Upper Head	L	F	N			UT	1	
224	12-Nov	Upper Head	L	F	N			UT	1	
225	12-Nov	Upper Head	L	M	Y			UT	1	
226	12-Nov	Upper Head	L	F	Y			UT	1	
227	12-Nov	Upper Head	L	F	N			UT	1	
228	12-Nov	Upper Head	L	F	Y			UT	1	
229	12-Nov	Upper Head	L	F	N			UT	1	
230	12-Nov	Upper Head	L	F	N	13105	7-Oct	T	1	36
231	12-Nov	Upper Head	L	F	Y			UT	2	
232	12-Nov	Upper Head	L	F	N	13111	7-Oct	T	1	36
233	12-Nov	Upper Head	L	F	N	13269	11-Oct	T	1	32
234	12-Nov	Upper Head	L	M	Y			UT	1	
235	12-Nov	Upper Head	L	F	Y			UT	1	

Table E-1. Upstream coho mark-recovery survey information for Zolzap Creek, 2004.

Fish No.	Date Recovered	Location Recovered	Rec. Type (L,D,A,N)[1]	Sex (M/F)	AFC (Y/N)	Operculum Tag Number	Date Tagged at Fence	Rec. Type Tag (T,UT,MT)[2]	Recap (1, 2)[3]	Residence Time
236	12-Nov	Upper Head	L	F	N			UT	1	
237	12-Nov	Upper Head	L	F	Y	13387	12-Oct	T	1	31
238	12-Nov	Upper Head	L	F	N	13316	11-Oct	T	1	32
239	12-Nov	Upper Head	L	M	N			UT	1	
240	12-Nov	Upper Head	L	F	N			UT	1	
241	12-Nov	Upper Head	L	F	Y	13263	11-Oct	T	1	32
242	12-Nov	Upper Head	L	M	Y			UT	1	
243	12-Nov	Upper Head	L	F	N			UT	1	
244	12-Nov	Upper Head	L	F	N			UT	1	
245	12-Nov	Upper Head	L	M	N			UT	1	
246	12-Nov	Upper Head	L	M	N			UT	1	
247	17-Nov	Goat Creek	L	F	Y			UT	2	
248	19-Nov	Reach 7A	L	M	N			UT	1	
249	19-Nov	Reach 7A	L	F	N			UT	1	
250	19-Nov	Upper Head	D	F	N			UT	1	
251	19-Nov	Upper Head	L	F	N			UT	1	
252	19-Nov	Upper Head	L	M	N			UT	1	
253	19-Nov	Upper Head	L	M	N	13307	11-Oct	T	2	39
254	19-Nov	Upper Head	L	M	N			UT	1	
255	19-Nov	Upper Head	D	F	N	13309	11-Oct	T	2	39
256	19-Nov	Upper Head	L	F	Y			UT	1	
257	19-Nov	Upper Head	L	M	N			UT	1	
258	19-Nov	Upper Head	L	M	N			UT	2	
259	19-Nov	Upper Head	D	F	Y			UT	1	
260	19-Nov	Upper Head	L	M	N			UT	2	
261	19-Nov	Upper Head	L	M	Y	13108	7-Oct	T	1	43
262	19-Nov	Upper Head	L	F	Y			UT	1	
263	19-Nov	Upper Head	L	F	Y			UT	2	
264	19-Nov	Upper Head	L	M	N	13270	11-Oct	T	1	39
265	19-Nov	Upper Head	L	F	Y			UT	2	
266	19-Nov	Upper Head	L	M	Y			UT	2	
267	19-Nov	Upper Head	L	M	Y			UT	2	
268	19-Nov	Upper Head	L	M	N			UT	1	
269	19-Nov	Upper Head	L	F	N			UT	2	
270	19-Nov	Upper Head	D	F	N	13316	11-Oct	T	1	39
271	19-Nov	Upper Head	L	M	N			UT	2	
272	19-Nov	Upper Head	D	M	Y			UT	1	
273	19-Nov	Upper Head	D	F	N			UT	1	
274	19-Nov	Upper Head	L	F	N			UT	2	
275	19-Nov	Upper Head	L	F	N			UT	2	
276	19-Nov	Upper Head	L	F	N			UT	2	
277	22-Nov	Goat Creek	L	M	N	13347	12-Oct	T	1	41
278	26-Nov	Upper Head	L	F	N	13391	16-Oct	T	2	41
279	26-Nov	Upper Head	L	F	Y			UT	2	
280	26-Nov	Upper Head	L	F	N			UT	1	
281	26-Nov	Upper Head	L	F	N			UT	1	
282	26-Nov	Upper Head	L	M	N			UT	2	

Table E-1. Upstream coho mark-recovery survey information for Zolzap Creek, 2004.

Fish No.	Date Recovered	Location Recovered	Rec. Type (L,D,A,N)[1]	Sex (M/F)	AFC (Y/N)	Operculum Tag Number	Date Tagged at Fence	Rec. Type Tag (T,UT,MT)[2]	Recap (1, 2)[3]	Residence Time
283	26-Nov	Upper Head	L	M	N			UT	1	
284	26-Nov	Upper Head	L	F	N			UT	1	
285	26-Nov	Upper Head	L	F	N			UT	1	
286	26-Nov	Upper Head	L	F	N			UT	1	
287	26-Nov	Upper Head	L	F	Y	13215	10-Oct	T	1	47

Average Residence Time (Live and Dead)	26
Number of unique coho recovered	248
Number of unique coho recovered tagged	59

Rec. Type[1]
L=Live
D=Dead
A=Angled
N=First Nations Harvest

Rec. Type Tag[2]
T=Tagged
UT=Untagged
MT=Missing Tag

Recap[3]: 1= First time recaptured
2= Recaptured before